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FOUR
DIALOGUES
BETWEEN
AN OXFORD TUTOR
AND
A DISCIPLE
OF THE
COMMON-SENSE PHILOSOPHY,
RELATIVE TO THE
PROXIMATE CAUSES
OF
MATERIAL PHENOMENA.

WITHDRAWN

By SIR RICHARD PHILLIPS.

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TO

S. L. MITCHELL, M.D.

&c. &c. &c.

OF NEW YORK.

Dear Sir,

In Europe, we look to America as the land of social and intellectual freedom, calculated, in due time, to effect the regeneration of all erroneous opinions. We suffer, in this quarter of the world, an experience of many evils which flow from errors, because we live in circles of mutual relations, which so entangle us, that, in defiance of the best intentions, we find it impracticable to emancipate ourselves.

Our institutions have grown, by degrees, to an imposing magnitude, but their foundations were laid in ages of superstition and intellectual darkness. Yours, on the contrary, have chiefly been founded on the long experience of Europe, and have sprung, at once, from the maturity of our knowledge. Our guide is precedent, often made in bad times, while yours is the reasonableness of the object, directed by the general will, which always averages human intelligence. We yield, implicitly, to the ascendancy of authorities long venerated, while the element of time, so necessary in conferring influence on authority, constitutes no part of your condition. All things among us are fixed for good, or for evil. Our customs, prejudices, and combinations, are too deeply rooted, and the sympathies of past, passing, and rising generations, are too much blended to admit of efficient correction and reform; while with you the choice is either still open, and, if made, is influenced, or has the facility of being influenced, by the neutralization of public opinion, and by those attritions of intellect, which, when free, necessarily decide in accordance with our best perceptions of truth.

At the same time, man is every where imperfect; his existence is too ephemeral, even for the wisest of his kind, to overcome all prejudices; and I do not imagine that Society in America is without many faults. You possess, however, the invaluable benefit of being able to correct them, by the popular character of your government; and while you enjoy

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that capability, you will continue to approximate towards perfection. You are strangers to the poisonous influence of high salaries and sinecure offices, by which public men in Europe find higher reward than in the love of their fellow citizens. You have few or no political and literary corporations, sustaining prejudices from generation to generation, with endowments to corrupt the members, and privileges to influence the community, the members of which fill up vacancies in their own numbers, and who, of course, always prefer suppleness and servility. With you, I trust, elections proceed from the external public voice, thereby conferring renovating vigour on your Institutions; and the titles of your candidates are, therefore, it may be supposed, their intellectual independence, and their superior personal qualifications. The reverse of these conditions are among the chief causes of the deterioration of Europe. The avenues to distinction are blocked up, and the generous spirit of emulation blighted, by close corporations of progressively diminishing intellect, by which the prejudices of preceding generations are avowedly and exultingly cherished; and every thing pre-determined by them, as by the Castes of Brahma, the writings of Confucius, or the Koran of Mahomet.

Under such circumstances, authority, on every subject, triumphs over reason, and improvements are recognized by bodies so constituted, only after many renewals of all the members. You will not wonder, therefore, at the inefficient progress, in Europe, of a system which illustrates nature on the simple and rational principle of *matter in motion*, and explain phenomena, by ascertained *transfers of special motions*. Doctrines about attraction, repulsion, gravitation, projectile force, caloric, &c. &c, are, of course, legitimatized in all such corporations. Belief in them is the test of worthiness; and eulogies, orations, and commentaries on them, are probationary exercises!

I do not complain, for the case is far from being new. Copernicus durst not publish, and think of living afterwards. Galileo suffered condemnation by the close corporation of the Inquisition. Kepler did not see any of his interesting doctrines recognized. Descartes was persecuted on pretence of Atheism. Newton, himself a Professor, survived his *Principia* forty-one years, yet scarcely had obtained its recognition by the close corporation of his own University.

I do not wonder, therefore, that a system promulgated only two years since, has hitherto made none but isolated converts, and none in seats of authority, who dare avow their faith. I claim no kindred distinction with the names mentioned, yet Truth and Philosophy claim universal respect, and it is their cause which I assert, for their own sake.

Of a successful result in Europe, I entertain no doubt;—but the adverse combinations, though unpremeditated and unaccompanied by moral or personal fault, are, by their radical texture, too strong to be speedily overcome. Our Royal Society, and the University of which Newton was the deserved glory, will publicly adhere to the letter of his doctrines, as long as ingenuity can uphold them. France, jealous of the renown of La Place, whose celebrity is founded on his illustrations of Newton, will long resist doctrines which render useless his profound applications of mathematics. Even America may, perhaps, take alarm at my proofs of the non-existence of an electrical fluid, while the glory of her illustrious Franklin is identified with its alleged reality.

Nevertheless, my dear Sir, America, as the Land of Freedom, must also be the asylum of Truth. She has few, if any, close corporations, the prejudices in which, from their constitution, must be directly, and the intellect inversely, as their age. Institutions are also constantly founded in her New States, and in rising towns, in which Truth may be adopted without the difficult task of unlearning and unteaching. America, too, promises a long and glorious career to all principles which she adopts. She is rising, while Europe, unhappily, is sinking under false policy, and worn-out institutions, and following fast the fortunes of Asia. Pride, and a short-sighted self-interest, will maintain her bad practices in the spirit even of defiance; and as America and her numerous republics rise, the glories of Europe must be gradually extinguished and shine only in the monumental page of history. I am anxious, therefore, that the Tree of Knowledge which I have planted, should be rendered indigenous in America, that its fruit may ripen in her extended climes, and that its worth may be justly estimated in schools of learning, whose walls are still imbedded in the quarries of your wildernesses.

To whom, dear Sir, can I delegate this task, better than to you, who for forty years have laboured so incessantly and so disinterestedly in the service of science, of your country,

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and of mankind,—to you who are, at once, so public spirited, and so zealous in every duty which you feel,—in fine, to you, whose cosmopolite spirit extends your celebrity as a man of science, and liberal sentiments, through the civilized world. I claim implicit credit only for my general principles,—partial credit for some of their applications,—and none whatever for some incidental speculations and isolated opinions, about which different trains of thinking, and new facts, may lead to different conclusions. This volume, in particular, I do not offer as a system, but merely as a series of brief and popular illustrations of subjects, treated more at large in my Twelve Essays, published in 1821; yet, even in them, not reduced to the elementary form of regularly developed science. That onerous task, I may never live to execute, but if it is ever undertaken by me, it will be a consequence, not a preliminary, of the public reception of my fundamental doctrines. I have, however, attempted to lay a solid foundation of natural philosophy, on which future labourers may erect a symmetrical and harmonious structure, satisfactory to reason, taste, and common sense. The principle of the division of labour, so useful in human pursuits, may justify me in considering that I have performed my duty; and without the hazard of suffering the imputation of idleness or indifference, I may, perhaps, leave to others, the task of filling in the details of a system of which I have drawn merely the outline.

I have the honour,
Dear Sir,
To subscribe myself,
With fidelity and respect,
Your obliged Friend,
R. Phillips.

London, January 5th, 1824.

ADVERTISEMENT.

The following pages exhibit the substance of several real conversations, which have lately taken place, between an independent Enquirer after Truth, and a liberal member of the University of Oxford. The spirit of the reasonings on one side is derived from the "Twelve Essays on the proximate causes of material Phenomena," which were collected and published in 1821; while the principles advanced on the other side, are those which, at different times, have appeared in the writings of Newton, Maclaurin, Horsley, Vince, Robison, Young, and others.

The objects of science discussed in these Dialogues, relate to the true causes of the Phenomena of

Attraction,
Repulsion,
Projectile Force,
Weight or Gravity,
Tides,
Elliptic Orbits,
Rotation of Planets,
Orbits of Comets,
Gases,
Liquids,
Solids,
Elasticity,
Heat,
Combustion,
Light,
Caloric,
Qualities of Bodies,
Electricity,
Galvanism,
Magnetism,
Affinity,
Definite Proportions,
Capillary Tubes,
Cohesion,
&c. &c. &c.

These subjects possess an eternal interest among the inquisitive part of mankind. Their causes and phenomena are here illustrated on entirely new principles. Instead of recognizing those innate properties *per se,* and powers *sui generis,* which have been introduced, *ad libitum,* into nature, an attempt is made to prove, that *various matter in various motion,* is the sufficient cause of these, and of all other material Phenomena. The advocate on the one side has endeavoured, in conformity to this general principle, to describe the *special* accidents of matter and motion, which concur in each case to produce the immediate result; while the advocate on the other has not been sparing in his objections, with a view to support the prevailing and fashionable doctrines.

The disputants refer their differences to the public at large, through the facility of the press. It is in the nature of an appeal to an impartial Jury; for the qualified judges in seats of authority, are unavoidably governed by prejudices created by education, habit, and attachment to doctrines about which they severally stand committed. A public Jury is, therefore, the suitable appeal, and to this great tribunal the respective arguments are submitted, in the confidence that, in due time, a just and operative verdict will be pronounced.

TWO DIALOGUES

BETWEEN

AN OXFORD TUTOR,

AND

A Disciple of the Common-Sense Philosophy.

DIALOGUE I.

Laws of Motion, and Phenomena of Aggregations of Matter; or Principles of Astronomical Physics.

OXONIAN.

I AM told you are a disciple of the New Theory of Physics. I am a disciple of Newton, and convinced by his mathematical demonstrations. I want no science beyond mathematical demonstration. What is contrary to it, I cannot listen to; and what, in other words, is the same, must be useless.

COMMON SENSE.

Mathematics constitute the science of number and quantity, abstractedly considered. Abstract numbers and quantities, as such, are susceptible of every variety of demonstration by mathematical science. But the moment we connect qualities with quantity, and material relations with numbers, mathematics demonstrate nothing in regard to those qualities or material relations, the introduction of which is arbitrary, and subject to errors, over which ab-

OXONIAN.

But I care not for the terms. It is to me a matter of indifference whether the centripetal force in the sun be caused by attraction or not. You grant, I perceive, that there is such a force, and that it diminishes as the square of the distance: all the planetary motions prove this law.

COMMON SENSE.

But if the force be centripetal, why do not the planets fall to the sun, and the satellites to their primaries?

OXONIAN.

They do fall:—they are deflected from straight or tangent lines by the centripetal force.

COMMON SENSE.

What straight or tangent lines?

OXONIAN.

What straight lines! Don't you know that there is a projectile force, which tends to carry them off, in tangents, to their orbits; and that they would so fly off, but for the centripetal force which exists in the sun with reference to the planets, and in the primaries with reference to the secondaries?

COMMON SENSE.

No; I know of no such projectile force, except through your assertion. It is mere hypothesis, and I admit of no hypotheses.

OXONIAN.

What! are you ignorant of the common experiment of a stone in a sling, which, when it escapes, goes off in a tangent?

COMMON SENSE.

I am not ignorant of it, but I see no sling in the heavens; and unless there be such sling, and a sling from the sun to every planet, and from every plante to its secondary, I see no analogy between this local experiment and the motions of the heavenly bodies. It is a symbol while it revolves, but in no degree analogous either in its parts or its mechanism, and, therefore, altogether figurative and irrelevant

OXONIAN.

It is an apt comparison, however, of the forces: the planets, like the stone, would go off in tangents, but for the centripetal or gravitating force; which force draws them from the straight lines in which they would otherwise move.

COMMON SENSE.

But you assume the existence of forces which I deny; and set about to prove their existence by your own hypotheses, that they do exist. I say there are no celestial slings, no motions in a straight line, no force to cause them, and no gravitating force.

OXONIAN.

You may be incredulous;—but I prove it by the composition of forces. The two forces, that in the right line, and that towards the centre, produce a diagonal motion, or generate a direction of motion, which is the curvilinear orbit of the planet.

COMMON SENSE.

And may not every motion be so composed?—may not two forces be imagined to produce every motion? Yet because you imagine the existence of two forces, does it necessarily follow that they exist? When a line of motion is produced by impulse, it cannot be reasonably referred to two forces, unless it be first shewn that the two forces really exist, and have a probable origin. How do you account for your two forces?

OXONIAN.

I appeal to the most common fact for the first force; the fall of a heavy body to the earth by a force which extends to the moon; and from the sun to the planets: and, for the second, to its necessary connexion with the first, to produce the result.

COMMON SENSE.

And how do you account for the fall of a body to the earth?

OXONIAN.

By a principle of matter; by an attractive quality in matter, through which all bodies reciprocally attract: a law coexistent with matter itself.—That power by which heavy bodies fall towards the centres of planets, planets towards the sun, and secondaries towards their primaries.

COMMON SENSE.

And is the fall of a body to the earth the only evidence you have of this universal principle, quality, or power?

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Oxonian.

It is sufficient: and Newton has shewn, that the moon falls in its orbit from a straight line, generated by the projectile force, through the very space which any other heavy body would fall at the same distance, and in the same time.

Common Sense.

That is, the moon is affected by a force which diminishes as the square of the distance.

Oxonian.

This is what I mean. But there are plenty of other instances of attraction, as capillary tubes, electrical attractions, chemical affinities, magnetism; and even Maskelyne has proved the attraction of a mountain, and Cavendish the attraction of two lead balls nicely poised. These are all so many proofs of an universal principle.

Common Sense.

Did it never occur to you to enquire, whether all these apparent attractions have a common cause, or special causes?

Oxonian.

I conclude, of course, that as they are so different, they must have special causes?

Common Sense.

And if special causes, then, of course, the several phenomena, though alike in appearance, are not the effects of an universal principle. Which of these do you think arises from an universal principle, and which from special or local causes?

OXONIAN.

Oh! beyond all doubt, the species of attraction which causes a body to fall to the earth is of the kind that is universal, or common to all matter.

COMMON SENSE.

The others, then, you think, may have special or local causes?

OXONIAN.

Why, I should think so; seeing that they are generated only under particular circumstances. I conceive, however, that all cases of attraction between simple bodies have the same general cause.

COMMON SENSE.

And did it never occur to you, to question the cause of this cause, and to doubt whether, like the other cases of attraction, the cause might not be special and local?

OXONIAN.

Never:—Professor Vince says, it is a miracle—a constant manifestation of the immediate power of the Deity; and he demonstrates, that it can have no mechanical origin.

COMMON SENSE.

So, when Maskelyne set up his apparatus at Schehallien, you think it was the Deity who pushed the plummet towards the mountain; and when Cavendish poised his lead balls, you think the Deity was employed in pushing them together! In like manner, when the Duke of York fired the first bomb-shell on Valenciennes, you think it was the Deity who precipitated the bomb-shell upon a house, by which a man, his wife, and ten children, were killed on the spot!

OXONIAN.

You talk blasphemously, and abuse the Deity!

COMMON SENSE.

No, it is not I who blaspheme, but you and your Professor Vince, who supersede Philosophy, and conclude enquiry, by bringing the Deity into the question!

OXONIAN.

But how else are we to account for it?

COMMON SENSE.

That is your affair; you invented it, and it lies with you to shew that it is reasonable. I agree with you that it is blasphemous to ascribe these minor operations to the immediate act of Omnipotence. But how do you account for your other force, your projectile, or right line force?

OXONIAN.

That is more easy; for all bodies have a tendency to move in right lines, unless disturbed or deflected.

COMMON SENSE.

Not without an original impulse, I suppose?

OXONIAN.

Oh no! the planets received this impulse at their that all the calculations are founded on mechanical principles, which conclude the will of the Deity.

OXONIAN.

Newton does not teach that the projectile force is kept up by a constant miracle. It was an original creative miracle, and the original force is still retained, because the planets move in spaces void of resistance, or in a vacuum.

COMMON SENSE.

Wonderful! so you invent, first, an universal gravitating force, and, then, a projectile force, both admitted miracles; and then, to confirm these, you render all space a vacuum!--Modest philosophy! Religious philosophy! Philosophy without hypotheses!

OXONIAN.

Hypotheses, no! we have no hypotheses! We begin with the fact of the fall of a body to the earth, and thence infer all the rest, by regular induction from the phenomena.

COMMON SENSE.

But, supposing the fall of a body to the earth should have a local and special cause; and that this cause should not extend, as you assume, from one planet to another; then the whole system would fail you, and you would, of course, acknowledge that your principles were untenable hypotheses.

OXONIAN.

If you shew that the fall of a body to the earth is owing to any local cause, and not owing to any universal principle; and can explain how the affections of the moon and of the planets are inversely as the squares of the distances, then our explication of the phenomena must be erroneous.

COMMON SENSE.

I have already shewn, that your's is not a rational system; that it depends on two constant miracles, as fanciful as improbable, and the *onus probandi* lies on you. But I have no objection to go further, and shew that your principle of attraction is a radical absurdity, and, therefore, ought to be the basis of no system; and, further, I will explain the true cause of the descent of bodies, and of the orbits and rotations of the planets.

OXONIAN.

If you shew that there is no centripetal force in the sun, I grant, that then, there can be no occasion for the projectile force; and if no projectile force, then no need of a vacuum in space; and, of course, the Newtonian physics must be abandoned, as the baseless fabric of a vision, which, in lasting for a century, have been maintained too long.

COMMON SENSE.

At the same time, Newton's mathematics and his physical principles must not be confounded. The geometry of Newton is immovable, but, nevertheless, his reasoning on the powers of nature, and his conception of the nature of those powers, may prove erroneous. In the age of Newton, trials for witchcraft were gravely carried on, and magic and astrology were in great vogue; it is not, therefore, to be wondered at, that parts of his philosophy were imbued with some of the metaphysical errors and popular superstitions of his age.

OXONIAN.

I freely admit that imaginary physical powers may be inadvertently combined with mathematical demonstration, and the latter may confer undue plausibility on the former. But Newton was an unfortunate man, if, after adopting from his predecessors a true law of nature, he erred in his view of its mode of action, and thus fell into a train of errors.

COMMON SENSE.

But that he was so unfortunate, I shall I trust shew. I have taken the *onus probandi* on myself, and am not afraid of the responsibility. It would be enough to shew the absurdity of the system now taught: —but something must be taught; therefore, until a reasonable system is proposed, instead of that which no thinking man can believe, a philosophy founded on complicated hypotheses will prevail over the simplicity of nature.

OXONIAN.

I am aware of difficulties in regard to many points of the existing physics, but am not yet prepared to go the length of condemning, in toto, what Newton has so ably demonstrated.

COMMON SENSE.

Demonstrated! he has simply demonstrated that the phenomena of the motions of the heavenly bodies agree with the law by which bodies fall to the earth, asserting that the gravitating power is inversely as the squares of the distances,—a law promulgated by Kepler and Hooke, and which is merely the law of divergence, or the law by which all forces are diverged through a fluid or gaseous medium.

OXONIAN.

Well, but how do *you* account for this law of gravitation?

COMMON SENSE.

It is nothing more than the law of divergence, or of radiation, as in light and heat. All forces diverging from a centre through water, air, or gas, are transferred to distances through them, by a law of divergence. They expand like a cone, as the squares of the distance, and, therefore, propagate force in the same ratio inversely. Water, and air or gas, are perfect levers, subject only to this law of decreasing force.

OXONIAN.

What! then you introduce into nature water levers, and aerial or gaseous levers?

COMMON SENSE.

Exactly so: and, in universal space, a gaseous lever is as perfect in its action as a lever of wood or iron; but all forces which are diffused within it, are diminished as the square of the distance. Such is the law by which the solar momentum, and the momenta of the planets are transferred from one to another; and it being so, we require merely a gaseous lever, or space filled with gas, to explain all the phenomena of the solar system.

OXONIAN.

But Newton says that space is a vacuum, or at most filled only with a rare ether, which in effect opposes no resistance.

COMMON SENSE.

Recollect why he said this; merely to get rid of the objection to his projectile force, founded on the alleged resistance it would meet with. But as a gaseous lever operates by the same law as gravitation, then there is no occasion either for gravitation, and for projectile force, and consequently no motive for annihilating matter from space. We have the same law of varied force without it; and no occasion for a vacuum, because the planets swim in the medium of space like ships in a current. Besides, void space, while gas is elastic, is a solecism, and the phenomena of meteors, comets, and planets, prove that the supporters of light and flame are to be found every where.

OXONIAN.

I confess I always have had difficulties in conceiving of void space while such a body as an elastic atmosphere existed in it; and whether gas exist universally and independently, which seems to be your notion, or whether the atmospheres of planets expand, it seems reasonable to conclude that space must be occupied; and if so, then the resistance would cause gravitation to overcome the projectile force, and the planets would be carried to the sun in spiral lines, which we know is not the fact. But how does your gaseous lever operate?

COMMON SENSE.

By action and re-action, proportioned to the quantities of matter and momenta of the bodies; and with reference to particular bodies, inversely as the square of the distances. Action, in the sun, diffused in gas, inversely, as the squares of the distances: re-action, in the planets, diffused by the same law. Action in the primaries, and re-action in the satellites.

OXONIAN.

But this is only a change of terms,—action for gravitation, and re-action for projectile force. You merely introduce a gaseous lever. Are we to quarrel about terms?

COMMON SENSE.

Certainly not: but we are expounding nature, and we may as well cease to enquire, as consider one explication to be as good as another. But this is not all; if action, through gas, is the sufficient cause of the planetary motions, it is a diverging, not a converging force,—a force parallel to the sun's motions, or proceeding from it, not towards it; consequently, it is not a centripetal force, and therefore the Newtonian projectile force, and vacuum in space, are as unnecessary as they are gratuitous and fanciful.

OXONIAN.

But would not the sun's mechanical action drive off he planets in a tangent?

COMMON SENSE.

No, the relative re-action would prevent it. The motions generated would always be similar to the generating motions. If the sun moves round the centre, or fulcrum of the solar system, the planets would move round the same fulcrum, in orbits whose dimensions would be inversely as their relative quantities of matter, and as the reciprocal squares of their distances. Kepler's law is a simple inference from this last law, and every other known law of planetary motion would equally accord.

OXONIAN.

The demonstration of Newton, in regard to elliptic orbits, and his application of his two forces, appear, notwithstanding, to be very satisfactory.

COMMON SENSE.

The eye never more completely deceived the understanding, nor words, reason. A figure is drawn with two ends, and the planet is made to turn a sort of corner, by a change, just at that point, in the balance of the forces, for the purpose of forming two equal sides of an ellipse. The planet is made to foresee what is to follow, and its present motions are made subservient to future ones. That is, the balance is turned just at the point which perfects the ellipse, for the sake of the true figure, as though the forces and motions were dependent on such result.

OXONIAN.

If the forces alternate in energy such would, nevertheless, be the fact.

COMMON SENSE.

If they do so!—and why should they do so?—A pretty reason, forsooth! A planet, in descending from its aphelion to its perihelion, is described as got the better of, by the central force of gravity; and although the force is constantly increasing, and the planet is rapidly descending in a spiral, with the direction of its orbit inclined to the sun; yet, on a sudden, its descent, with a velocity created from moment to moment, is arrested by the alleged projectile force; and the body, disobeying the cause of its own velocity, is then made to pursue a new direction in a tangent.

OXONIAN.

Yes; but it would be so at the apex of an ellipse.

COMMON SENSE.

Never was the deception of applying geometry to such considerations rendered so obvious as by your observation. Do you suppose, then, that there is any ellipse in the heavens? Do you make the ellipse, or any circumstance of an elliptical figure, the cause, or the concurring cause? If there is no fixed ellipse in the heavens, then your two forces would never turn the apex of an ellipse, and the aphelion distance would for ever increase, and the perihelion decrease till the planet reached the sun; while, it should not be forgotten that the acting forces themselves are absurd and fanciful.

OXONIAN.

I see and feel your objection, but have you a more plausible theory?

COMMON SENSE.

Perhaps, not quite so plausible to those who do not think, and who make the independent continuous forces of nature in the heavens, succomb to the accidents of an ellipse! My theory shall have, however, real matter and motion for the causes; and the changes in the planetary energies shall be shewn to be necessary consequences of changes in the direction of the palpable forces. The ellipse shall be a consequence, and not a cause.

OXONIAN.

Then I perceive you entirely dispense with universal gravitation; but is it not proved by the fall of a heavy body to the earth?

COMMON SENSE.

No such thing: the fall of a heavy body towards the centre of the earth, or any other planet, is a local effect of the motions of the planet. The two-fold simultaneous motions cause the aggregation of the mass, and consequently the tendency of every part to fall towards the centre of the mass.

OXONIAN.

Hence then the two-fold motions have another great object, besides the phenomena which they produce, in varied light and weather.

COMMON SENSE.

These phenomena are subordinate and incidental,—the aggregation or concentration of the mass is essential.

OXONIAN.

This doctrine is important, and if established, will change my views of nature: I have always, and without suspicion of any other cause, ascribed the consolidation of masses to attraction.

COMMON SENSE.

What do you mean by attraction?

OXONIAN.

The effect of bodies approaching without any sensible cause.

COMMON SENSE.

But do you suppose there is no cause?

OXONIAN.

Causes have been imagined; Newton himself guessed at some, but Vince shews that it cannot be mechanical, and must be a miracle.

COMMON SENSE.

Do you as a philosopher insist on this?

OXONIAN.

No, I do not; miracles cease when philosophy begins, and philosophy ceases when miracles begin.

I admit, generally speaking, that miracles are the last resort of ignorance and superstition.

COMMON SENSE.

Well, then, there ought to be a sufficient cause found for every species of attraction; and when not found we ought to examine further, and not ascribe the effect to miracle. Nature, in the vast and minute, and in the continuity of being, is the great, permanent, and sublime miracle of the Deity; and is only worthy of his attributes in being carried on by eternal general laws, and in not standing in need of local or temporary miracles. To suppose the necessity of a miracle is to arraign the Divine attributes.

OXONIAN.

But, it is a fact that bodies move towards one another; boats congregate round ships,—corks round bungs,—bungs about the sides of vessels,—stones fall to the earth, and they all move with an accelerated velocity, and inversely as their matter.

COMMON SENSE.

But if they move towards one another, whence comes the moving force? Must it not be in the line of direction, or from the opposite sides, as if A move towards B, and meet it at C; and B towards A, must not the moving forces be respectively in the parts D, and E?

D + ○ A .... C .... B ○ + E.

OXONIAN.

Doubtless if A move to C, the moving force must be from the part D; and if B move to C, the moving force must be from the part E. The force must necessarily be in the direction of the motion.

COMMON SENSE.

Yet you say A moves B, and that B moves A; or, in other words, you say that A acts with force at E, beyond B, *where it is not;* and that B acts on A, in the parts D, beyond A, *where* B *is not.* Is not this impossible and absurd? yet this is an analysis of the famed doctrine of attraction.

OXONIAN.

I confess I had not previously analyzed it. I feel the force of the argument, and never again will use the term attraction, without qualification. After all it may be a miracle, and, in spite of reason, I must therefore admit miracles into nature.

COMMON SENSE.

Then we seem to agree in this,—that attraction is either an absurdity, or a miracle. But supposing a sufficient mechanical cause can be assigned for every variety of the unapparent cause of the approach of bodies, then I suppose you will abandon your miracle?

OXONIAN.

Doubtless; I have too sublime and too reverential an idea of the Deity to suppose that miracles can ever be necessary in the ordinary course of Nature. His omniscience renders it certain that the mechanism of his universe must be equal to all its necessary purposes.

COMMON SENSE.

That attraction is a mechanical operation is proved by the general considerations that the effect is always reciprocally proportioned to the quantities of matter concerned,—that it is subject to a law of the distance,—and that the motions produced by it are mechanically accelerated. In fine, all momenta result from quantity multiplied by velocity; and therefore all velocity, or motion, must be momenta divided by quantity. If the cause of velocity were a miracle, we could not calculate any thing!

OXONIAN.

This I have always thought, yet have found it difficult to refer the phenomena to their specific causes. If mechanical, then no miracle; and, if a quality of matter, then absurd in its operation. I see no escape from this dilemma, yet the admission is dangerous. It applies to the entire circle of natural philosophy. I cannot help clinging to the delightful term, it accounts for so much, and is so pleasing and magical. We see an effect, and we ascribe it to attraction, or gravitation, or repulsion, and these terms save so much enquiry.

COMMON SENSE.

To confer on matter the power of attracting or repelling, is to confer on it the powers of divinity. It is making inert matter equal to God; and if the motion which masses produce during mutual attractions is proportioned to the quantities, the masses must then be *sentient* in regard to their relative importance. The proposition is silly; while the fact really proves that the cause is mechanical. In all supposed attractions the momenta are constantly equal, i. e. the spaces moved through, multiplied by the quantities of matter, are always equal.

OXONIAN.

I admit it is so, and I must always have been of opinion, that so regular a result must be mechanical, if I had analyzed the subject. What, however, is your explication of the mechanism by which the several varieties of attraction are effected?

COMMON SENSE.

I have told you, that in the case of a heavy body falling to the earth, it is owing to its two-fold motions. All the bodies on the earth compose one great system, subject to common forces and motions, and every part must yield to the motions of the whole. The actions and re-actions are reciprocal, but the mass prevails, and hence the parts are forced to respect and fall to the centre of the mass.

OXONIAN.

Be more particular.

COMMON SENSE.

To simplify the explanation, I shall first draw your attention to the effect of a rotatory force on the several rotating planes, from the equator to the poles; and then connect these with the orbicular motion, which has a common operation on the whole. The earth revolves on its axis, and some common force revolves it.

OXONIAN.

You mean that there is but one revolving force to the whole, and if so, then I understand you. This common force must, of course, have a tendency to revolve every part of every circle of latitude in its own plane, with an equal relative momentum.

COMMON SENSE.

I thank you for this inference, because it is a step towards the mystery. Another step is necessary, the velocity of every part must be as its distance from the axis of rotation.

OXONIAN.

This I understand: the velocities must be as the circles performed during the diurnal rotation.

COMMON SENSE.

But you just now admitted that the common force tends to confer on every part of every revolving plane equal momenta,—consequently, if the velocities are as the radii, the densities, taken from the axis to the circumference, ought to be inversely as the radii; for the velocities, multiplied by the densities, ought every where to express the equal momenta. But as bodies of various densities are not thus situated, so dense bodies have a constant tendency to fall to distances from the centre inversely as their density; and hence, if any dense body ceases to be supported, or is surrendered to the action of the system of the earth, it falls, or endeavours to fall, to a circle of rotation inversely as its density.

OXONIAN.

Of course then the densities must increase as we approach the axis; and if the parts were free to move one among the other, the earth would consist of strata whose densities would be inversely as the distance from the axis.

COMMON SENSE.

Then a falling body is in such condition. It is free to move, and therefore seek the axis; while all bodies have a tendency to fall towards the axis, though the structure of the earth, and various circumstances, prevent their fall.

OXONIAN.

This is very ingenious, as far as it goes, but it does not accord with the fact. Bodies do not fall perpendicularly towards the axis, but towards the centre.

COMMON SENSE.

Agreed; but we have yet spoken only of the smaller of the earth's motions, the rotatory motion, which is but the sixty-eighth part of the other, or the orbicular motion, even at the surface of the equatorial circle!

OXONIAN.

Well, but what has the orbicular motion to do with it? It is 68 times greater, but how does it operate?

COMMON SENSE.

It is not difficult to conceive: it depends on a very simple principle.

OXONIAN.

What is that?

COMMON SENSE.

All the parts of any heterogeneous mass in motion, seek the plane, or line, of their common motion, or centre of their common force; like a projected heterogeneous mass, or meteor, which forms a train on each side the centre of motion, which centre the whole seeks.

OXONIAN.

I comprehend; they tend, as it were, to collapse to that plane; so that while the rotatory force tends to assemble them round the axis, the orbicular tends to carry them towards the centre of its plane of motion. All the parts, therefore, are simultaneously subject to two forces, or motions.

COMMON SENSE.

Just so; the two forces are perpendicular to each other; that towards the axis is like the co-sine of the latitude, that towards the plane of the equator is like the sine. Of course the actions of both carry all bodies in the diagonal of those sines and co-sines, which is always in the radii or towards the centre.

OXONIAN.

I still have difficulties, and will freely state them. Would not a revolving mass throw bodies off in a tangent, instead of assembling them near the axis? We know, for example, that a stone flies off from a sling; and all circular motion must be the effect of restraint. Free motions must be made in straight lines; and the circular motions of heavy bodies on the earth prove a restraint like that of attraction.

COMMON SENSE.

Nobody can doubt that bodies put into circular motion would fly off in tangents if unrestrained. But a circular motion may be relative to other motions, and subordinate to them. The circular motion may be a result of combined forces, and not an original motion. Forces may be so combined as to constitute, in union, the restraint which carries bodies round in circles. If the earth simply revolved in one place, the impulse on the bodies composing it would unquestionably carry them off in tangents; but if another motion is given it, whose minimum in any direction in which it is moving, is greater than the maximum of the centrifugal force, then circular motion may, nevertheless, be a result of the two forces; while if the other motion were still further increased, they might even be deflected inward, instead of outward.

OXONIAN.

I perceive you refer to the simultaneous orbicular motion, which being 68 times greater than the rotatory motion, would have certain effects on the rotatory motion, and perhaps destroy the usual tendency of circular motion to create a centrifugal force; nay, I perceive that if it were increased to a certain extent, it might reverse the effect, and create a centripetal force. But though the motions would oppose each other on one side of the earth, so as to produce centripetal force, would they not combine on the opposite side, so as to add to the centrifugal force?

COMMON SENSE.

You treat of the rotatory force as an original independent force; whereas it merely grows out of the other, and is but the portion of the orbicular force (which acts more on the hemisphere near the sun, than on the remote hemisphere;) and it is, therefore, consequent and subordinate. But it is a globe, not a cylinder, which is acted upon, and the collapsing force resulting from the orbicular motion inclines the poles to seek the plane of the equator; and hence, doubtless, the flattening of those parts, and the form of the oblate spheroid. This collapsing force inclines all bodies to fall towards the plane, or centre, of motion, and operates in the direction of the sines, or perpendicularly to the plane of the equator. At the same time this tendency is so counteracted by the rotatory or centrifugal force, operating at right angles, as the co-sines of the sphere, as to produce the result of the globular form, and the tendency of all bodies, in all situations, to fall to the centre of the system. In producing the centripetal force, the orbicular collapsing force is positive in its action, but the rotatory is negative. At the Equator it is a minimum, and at the Poles a maximum. While the cosine increases, the sine diminishes, and they vary as one another, each correcting the anomaly of the other. The square of the radius is a constant quantity, or nearly so, and the forces are represented at the Equator and Poles by the squares of the Equatorial and Polar diameters. One consideration should always be borne in mind, that in a system of connected bodies, like those of a planet, the same law of force results from the distribution of varied density, as in a fluid medium, from the distribution of varied force; and hence the same law prevails from varied density within the mass of a planet, as from diffused force in a gaseous or fluid medium.

OXONIAN.

I perceive then, that these forces would not be varied by the direction of motion; and that the bodies on the earth, when adjusted by the first motions, and these unceasing, would be governed by the paramount continuous motions. I could liken the results to what takes place in a ship at sea, and extend the analogy by supposing it to turn on the same spot, and in progression; but I am afraid of comparing motions in nature with the relative ones on the earth. It seems to me, however, that if the earth turned in one place it would resemble a Catherine wheel; or projected in a right line, would resemble a Rocket with its train; but simultaneously revolved and projected, the effect would be reversed in one case, and in the second the train would be licked up, or whirled round like the atmosphere.

COMMON SENSE.

Our experiments on moving bodies on the earth is like shooting at a mark on board of a ship which is sailing at the rate of ten knots an hour. It was thus in Newton's experiment of the rotatory bucket; an horizontal velocity was given which destroyed the weight of the water at the sides, where the motion was greatest, and caused the central parts to take its place, and push it upwards. It had nothing to do with centrifugal force.*

OXONIAN.

I understand it better; but you have not spoken distinctly in regard to the varied effects of the orbicular motion, when it coincides with, and opposes the centrifugal force of rotation, or is sideways, or neutral.

COMMON SENSE.

My answer included that point, but I will enlarge upon it. The orbicular motion is constant, and applies to every particle of the mass wherever it is situated. It is the same thing whether it oppose the centrifugal motion, or the centrifugal motion oppose it. The action of progression is constant, and the only difference arising from position is in the interchange of actor and re-actor. Besides the equilibrium being acquired, the common force which revolves the mass cannot carry a dense body in a large circle of rotation, while the equilibrium enables it to carry in that circle only a rare body. For example, if the equilibrium of the forces enables the earth to carry round a cubic foot of air at the distance of 4000 miles from the centre, the same common force of rotation will not enable it to carry round a cubic foot of lead in the same circle. The lead or the whole earth must give way, i. e. the lead must sink, or have a tendency to sink, to a circle of rotation, inversely as the atoms in the two bulks, or a miracle must take place, and the centre of the earth approach the lead. Hence, the equilibrium being acquired, and the motions being constant, no variation in their *relative* directions and position can produce any sensible change in the effects.

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* As these successive expositions of the doctrines of Newton may offend the predilections of many readers, it is necessary to remark, that the author, nevertheless, considers Newton as one of the greatest geniuses that ever appeared in the world. In Physics he erred, in adopting weight *per se*, as an universal cause; in his views of centrifugal force, and in considering motion subordinate to other active causes; and in optics, in considering light as the propagation of identical atoms; but, had he lived in a later period, his genius would have surmounted these errors, and he would have erected a perfect system of Natural Philosophy. Those are the worst enemies of Newton, who justify the errors of his age, and violate our better knowledge, under pretence of guarding his personal fame.

OXONIAN.

I think the shortest way of expressing and conceiving the whole is to say that all the parts of a planet are a system of bodies subject to common forces, with various re-actions according to their densities; that these re-actions, when great, as in dense bodies, cause them to be patients in a less degree, and therefore, suffering the least change or motion, they go to the centre; while rare bodies, suffering the most, partake of the greater motions in the circumference.

COMMON SENSE.

You have expounded a law of dynamics which applies to the whole of the phenomena.

OXONIAN.

This objection is answered; but how can accelerated motion be produced without innate gravity?

COMMON SENSE.

Accelerated motion is merely the effect of a continuous force, any how produced. Continuous motions, like those of the earth, as the causes of the fall, produce it as well as attraction, if so foolish a property can be gravely quoted. But I advise you to say nothing about accelerated motion, for if universal gravity caused the motion of the planets, they would have been accelerated ever since this gravity began to act; and instead of sixty-eight thousand miles per hour, the earth would, ere this, have moved through millions in a minute. Acceleration would be a necessary consequence of such a constant power as innate gravity; but not of impulses, such as those of the sun through gas, in which the effect is successive, and always reciprocally as the cause.

OXONIAN.

I perceive that you maintain that the very principle of bodies attracting one another is a mechanical absurdity, consequently that the sun cannot attract the planets, nor the earth a heavy body. The solar system is therefore without a centre of attraction, and the diagrams of Newton, as far as they are connected, apply only to action and re-action through a gaseous medium, which transmits forces inversely as the squares of the distances. You think Newton was wrong in ascending from the earth to the heavens, and extending the laws of terrestrial projectiles to the planets?

COMMON SENSE.

Yes, inasmuch as the force which operates on a body, by the earth, is a local force generated by the local motions of the earth; and as every other planet in like manner generates its own force of aggregation, so there can be no analogy; unless the planets exhibited the same phenomena with regard to the sun, as bodies connected by motion with planets exhibit in regard to them.

OXONIAN.

You mean, I suppose that the sun ought to revolve the whole in the period of his own rotation, just as a projected stone is revolved by the earth?

COMMON SENSE.

Exactly so. Their motions ought to be similar, and they ought all to revolve in the same time. Instead of which, they revolve by a law of diffused force, acting by propulsion, through a medium; and though moved by the sun, are not part of its aggregate like a terrestrial projectile. It happened that Newton adopted the law of divergence, though he did this by an erroneous mode of reasoning, and hence his calculations are correct; while his diagrams apply nearly as well to a diverging force as to a converging one.

OXONIAN.

The difference between the two systems then, if I understand you rightly, is as follows:—you adopt the law that the forces are inversely as the squares of the distance, but you do not ascribe it to the sun's attraction, but to the action of the sun on the medium of space, which carries round that medium and the planets with a force, or velocity, which is every where as the square of the distance; the variation in the periodical times being caused by the law and by the varied re-actions of the planets, depending on their varied quantities of matter.

COMMON SENSE.

This is an abstract of my doctrine, and I thereby clear nature and philosophy of the compound absurdities of attraction, projection, and vacuity in space.

OXONIAN.

Then it seems you reduce, or would reduce, all phenomena to your own principles of material action, and equal re-action, visible or invisible. It behoves you to explain what you mean by these terms.

COMMON SENSE.

By action I mean the power which any body or atom possesses of transferring its motion to any other body or atom, so as to disturb its relations to other bodies and atoms, and produce change or phenomena.

OXONIAN.

So then two terms are essential to all action, matter and motion, and the quantity of action is proportioned to the product of the quantities of each?

COMMON SENSE.

You are right; wherever action or force appears, there must be some matter and some motion. To determine the cause, then, which produces any changes or phenomena, we must ascertain the matter and motion concerned, and the mode in which the action is transferred to the bodies in which the phenomena appear.

OXONIAN.

Favour me with an example.

COMMON SENSE.

If a billiard ball moves, this phenomenon is caused by the motion transferred from my hand through the mace, and my hand is the proximate cause. If this move another ball by a direct stroke, it stands still, and transfers the whole of its motion to the second ball, and the cause of the motion of the second is the motion multiplied by the matter of the first. When the second stands still it has parted with, or transferred, its motion to the surface over which it rolls, and to the atoms of air through which it has passed. The former is called friction, and the latter resistance; but they mean nothing more than the capability of receiving the motion from a body in motion; and they receive it in the ratio in which the surface is rougher, or the medium denser, or as the number of atoms receiving the motion.

OXONIAN.

So then resistance and friction, about which so much metaphysical enquiry has been employed, are, in fact, nothing more than means of receiving motion from a moving body?

COMMON SENSE.

You are right; there is no mystery, unless mystery is invented. But I have described only one case of action, in which the force is transferred directly and wholly from body to body. In other cases the transfer is mixed, as for example, if I place three or four small pieces of paper on a table, and strike it smartly with my hand, the motion of my hand is transferred partly to the earth through the table, and partly to the air. This, as a fluid medium, carries the motion around, or radiates it in a circle, and in this manner it reaches each of the pieces of paper, with a force which is inversely as the squares of their distances from the hand. The papers are incidentally affected, as being within the sphere of air, but the motion is transferred to all the surrounding atoms of air, by the same law of decrease, and this I call a *gaseous* lever.

OXONIAN.

I expected to hear something of re-action.

COMMON SENSE.

You have heard all you can hear. The reception of the motion by the other bodies and atoms in each case, constituted the re-action, which, in truth, is nothing more than the reception of the motion parted with. To receive motion, is to receive force or momentum, and this is called re-action. It is, of course, equal to the action, because it is only the action itself transferred.

OXONIAN.

But what becomes of the motion received, or which, as received, is, with reference to the first mover, called re-action?

COMMON SENSE.

It is re-transferred, from body to body *ad infinitum*, and never ceases to produce some effect, though scattered and insensible. If I strike my hand on a table, the power to do so is derived from gas-fixing by the lungs; but the motion transferred is derived from the action of my feet against the ground. I am a lever, deriving my energy as such from gas-fixing, and my feet are one end, and my hand the other end. In striking the table I return the motion partly to the earth, partly to the gas within the table, and partly to the atoms in the surrounding air.

OXONIAN.

What, in a general sense, becomes of motions transferred, and whence come the motions received?

COMMON SENSE.

They are often specially appropriated, and specially derived; but they are more commonly absorbed and evolved by the great stock of motion which fills the universe, and is distributed among masses and atoms.

OXONIAN.

As bodies, or atoms, cannot originate their own motion, how do you account for the primary origin of motion?

COMMON SENSE.

The origin of motion must, of course, be referred to God, the eternal architect of the universe. Inert matter cannot move itself, much less can it have any motive power to move. It is the climax of nonsense, to ascribe to it active powers as originators, or renovators of its motion, like Newton's attraction, repulsion, and fermentation. We have no abstraction higher than matter and motion, till we arrive at the inscrutable FIRST CAUSE.

OXONIAN.

Which of the two, aggregates, or atoms, do you consider as first movers in the material universe?

COMMON SENSE.

Aggregates are local—atoms are universal. I conceive that atoms move aggregates, and that all motion is diffused by and through atoms, and transferred to aggregates.

OXONIAN.

It seems hard to believe that atoms should move such bodies as the Sun, the Earth, or Jupiter.

COMMON SENSE.

When no other force is applied, the slightest will give direction of motion; the planets swim in the medium of space, like ships in a current of water, and we do not wonder at a heavily laden vessel being carried before a current; and, with reference to the rotation, the sides are exactly balanced, and a man may turn an horizontal wheel, thirty feet in diameter, with his little finger.

OXONIAN.

As you ascribe the revolution of the planets to the action of the sun; to what do you ascribe the motion of the sun? I am aware that, in regard to terrestrial phenomena, it is an ultimate, and not a proximate cause; yet, with reference to the planets themselves, you render its motion the proximate cause; and though we ought to be satisfied by attaining a correct knowledge of proximate causes, yet curiosity will lead us to enquire about causes of causes.

COMMON SENSE.

In replying to your question, I would remark, that I have no better analogy to guide me, than the system of Jupiter and his moons, which may be likened to the sun and planets. In one case, re-action seems sufficient to explain the motions of Jupiter; and we are assured by Herschel, that the sun has a direct motion in space towards certain parts of the heavens, such as that of Jupiter in his orbit. Perhaps, the cluster in which the sun is situated, and all clusters may revolve; and, by the bye, it is fortunate for them that there is no mutual attraction or universal gravitation!

OXONIAN.

But what re-action, when Jupiter's moons are 90° distant from each other?

COMMON SENSE.

The general orbit of Jupiter round the fulcrum of his system, as the preponderating mass, would be little affected by the occasional positions of his satellites: so with the sun, in regard to the planets, when scattered in the zodiac at various distances.

OXONIAN.

What do you understand by *inertia*, and weight or gravity?

COMMON SENSE.

By these synonymous terms I understand the same thing as momentum in a particular direction. On the earth they are caused by the two-fold motions, which confer velocity towards the centre, and in regard to any re-action, are estimated by the number of atoms, the motions being common. When the body is free to fall, and falling we call the momentum *weight*, which, to puzzle the vulgar, Newton translated into *gravity;* but when the fall is intercepted, and the body at rest, but with a tendency to fall, we then call the force which it opposes to any re-action, *inertia*. Of course bodies subject to no motions exhibit no momenta, and neither weight, gravity, nor inertia; therefore it is most absurd to call them absolute properties of matter.

OXONIAN.

How does the earth acquire the motion which th hand transferred from it in striking the table?

COMMON SENSE.

From the sun; which, in revolving round the centre of the momentum of the solar system, carries round the medium of space, and operates at different distances inversely as the squares of the distances; a force, which, combined with the re-actions of the planets, as determined by their density and bulks, produces their respective orbits; while the difference between the same force on their near and remote axes carries the hemispheres round the axes.

OXONIAN.

The re-action alluded to is equivalent in effect to the suggested centrifugal force of Newton; but is the difference of the forces on the near and remote axes, or hemispheres, equal to the rotatory motion?

COMMON SENSE.

Exactly so: the difference, compared with the whole force, and applied to the centre of percussion, is precisely equal to the motion of the earth at the equator.

OXONIAN.

Again, if the two-fold motions produce the fall of bodies, those forces ought to be such as would produce the known fall of a body in a second.

COMMON SENSE.

This has been calculated, and is found to correspond precisely. The two calculations justify the reasonableness of the theory.

OXONIAN.

But if the uniform medium of space is moved
the sun, would not its velocity be as the distar
from the sun, and the motion of the planets in th
orbits be in the same proportion, and would not t
force be as the velocit ?

COMMON SENSE.

It might be so, if the force proceeding from t
centre were not, at the same time, diffused as t
square of the distance, consequently, the velocity w
be as the force, for it cannot be greater than the for
producing it. Besides, the increments of solar for
being the source of the forces, the momentum of t
sun is transferred in successive increments, throu
space, and reaches each planet in its diffused sta
generating tangents, or chords of motion corr
ponding; which are to the solar increments direc
as the momentum of the vast body of the sun, a
inversely as the square of the distance, combin
with the quantity of matter, or re-action of each
the planets.

OXONIAN.

If I understand you rightly, the whole force of t
sun is, on your principle, not directed to the plane
but diffused through all space in the plane of its m
tion; and as the medium of space is affected i
versely, as the squares of the distance, so by the for
received, and by that only, the medium affects t
planets.

COMMON SENSE.

In fact, a medium thus acted upon by a central force, which diminishes as the square of the distance, performs its own revolutions, according to the same law; for it is not continuous, like a rod, or the spokes of a wheel, but yielding and elastic, and thence the law of diffusion.*

OXONIAN.

I had erroneously considered it like the spokes of a wheel, and hence my error. But the circumstance, that the maximum of force is limited to the plane of the solar motion, seems to confer another particular character on this gaseous vortex. It must expand as it procceds, and diminish so as to produce peculiar effects on planets, in passing their nodes, and on comets advancing into our system.

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* In conformity with this principle, Mr. C. Busby has constructed an Orrery moved by water. In the centre of a large open tub he has placed a hollow tin vessel, which he makes revolve in a small orbit, by erecting a tin vane, or sail, and burning before it a small lamp, which rarifies the air, causes a current, and the current revolves this centre, or supposed sun, in the water, with a quiet, equable motion. He has then placed, at proportionate distances, circular tin troughs, to swim on the water, representing the orbits of the planets. No motion is visible in the water, but the quiet central motion in the centre, proves sufficient to carry round the concentric tin troughs, in times which are to the several distances, as the squares to the cubes. The force is, of course, diffused through the water inversely, as the squares of the distances, and the resulting proportions are the consequence. Nothing can more beautifully exemplify the system of forces, diffused through a medium, combined with equal action and re-action.

COMMON SENSE.

To this circumstance may be ascribed all the phenomena of comets, which usually have great declination, and seem to be moving in straight lines, till they get involved in the solar vortex. The theory in question solves the chief of their known phenomena.

OXONIAN.

You surprise me by your observation about comets, a species of bodies of which we know so little, and which seem to be so far removed from our means of knowing more.

COMMON SENSE.

I speak with reserve on a subject on which some guesses must have place. Thus we know not whence comets come. Nor, in assuming that they move through space in right lines, are we able to account for the impulse which they must have received. But if, in proceeding through space, they come within or through the diverging plane of the solar vortex, and therein encounter a rotatory force in the direction of the medium of space, this force, combined with their own rectilinear force, would carry them round the sun in perihelio; and that they do not fall into the sun may arise from the impulse of the solar atmosphere when that body is approached.

OXONIAN.

It seems, therefore, that the solar vortex may be likened to a sort of wedge, whose edge is the breadth of the sun, while the distant parts expand, and widen in space, and viewed vertically, would be like a fan.

COMMON SENSE.

The planets move near its centre, and obey its force, but the comets are unaffected by it, till, in their erratic course, they actually cross it. While in it they would then yield to its action, and perform orbits like the planets, but for their own rectilinear force. The solar vortex, in that case would deflect the comet from its own right line course, more and more as it approached the centre of the wedge, or plane of the solar momentum; and these continued deflections, constantly increased, would carry the comet towards the sun. The fall into the sun would then be prevented by the great re-action of the solar atmosphere, and the comet would be driven off in a right line, the deflections of which would decrease, instead of increasing, as in the former instance. Our sun, like an exploding body, would give the comet an impulse which would carry it to another system, where it might undergo a similar fate, from a similar cause.

OXONIAN.

Hence the planets may have been comets which have fallen so obliquely, or with such languid motion, on the solar vortex, as to have become entangled within it, and carried round in their present orbits. This would explain many geological phenomena, and agree with the Plutonian theory. Does it not also seem to explain the cause of elliptic orbits?

COMMON SENSE.

Certainly not, for we have no method of explaining why the comets do not enter the sun but the re-action of the solar atmosphere, which the planets, when in perihelio, do not reach; and the lines of apsides of planets, appear to have no connexion with their nodes.

OXONIAN.

This theory of two forces in comets reminds me of Newton's theory, though very different.

COMMON SENSE.

I entertain no doubt but the motions of the comet of 1680 led Newton to publish his Principia in 1687; only he fell unluckily on the theory of universal gravitation, and sought to extend the principles of cometary motion to those of the planets. He generalised too much, and in universal gravitation and attraction fell upon a principle mechanically and metaphysically absurd.

OXONIAN.

What density do you assign to the medium of space?

COMMON SENSE.

The rarer the medium, the more sensibly is it acted upon. Thus mercury propagates motion less sensibly than water, and water than air, and rarer gas than air. But there may be a limit, and that limit I cannot pretend to assign, but it is indifferent, because the planets swim in it like balloons in the atmosphere, and experience no resistance.

OXONIAN.

As you do not ascribe the elliptic orbits to any rectilinear force in the planets, nor any connexion with the nodes, or passage of the plane of the solar momentum, how do you explain them on your theory of action and re-action.

COMMON SENSE.

I thank you for this question, for as the sun's attraction, or re-action, are constant quantities, it demands special consideration on either hypothesis. Of course the variation must be sought in the re-action of the planet. When this is greatest, its lever, or distance, is shortened, and vice versa. Behold the facts: the earth is in its perihelion when the southern hemisphere is presented to the sun, and in its aphelion when the northern hemisphere is so opposed. In the different circumstances, then, of those hemispheres, we must seek for the cause in varied re-actions. What are the materials re-acting?

OXONIAN.

I am astonished at the coincidence. I perceive that water is opposed at one time, and solid land at the other. The moving waters obviously create a greater terrestrial swing than the fixed land, and thus the earth descends and ascends in its orbit, in proportion as its re-action increases or diminishes.

Doubtless also the same causes affect the orbit of the moon. The mysteries of Nature seem developed in the transfers of motion, or of action and re-action, through gaseous levers!

COMMON SENSE.

The progression of the line of apsides, the geological changes on the earth's surface, &c. &c. all yield to the same principles; but I cannot pursue the details through Nature. "All discord's harmony not understood."

OXONIAN.

How, on this system, do you account for the tides?

COMMON SENSE.

Do you believe that the moon pushes up the waters from under the sea? Yet is not this the necessary mode in which the moon must act if she attracted them?

OXONIAN.

Attraction! pshaw! why quote such an absurdity; I blush at having been so long its dupe. But I say again, how do you illustrate the tides? They are palpably connected with the positions of the moon, and with the sun and moon.

COMMON SENSE.

The tides arise from inequalities of the earth's motions, owing to the mobility of the waters; and these inequalities are produced by the re-action of the moon, and hence the connexion of the motions of the waters with the moon.

OXONIAN.

You develope a general principle, apparently correct, but I do not see its application.

COMMON SENSE.

Mark then: the earth and moon are a system of bodies acted upon by the sun, while they act and re-act on each other, and move round a common fulcrum, which, with reference to the solar force, is their centre of percussion.

OXONIAN.

We recognise these principles, and it is agreed that it is the fulcrum which performs the orbit round the sun, while the earth and moon perform orbits round it, proportioned to their quantities of matter.

COMMON SENSE.

Not exactly so, for the fulcrum would be distant from each respectively as their quantities of matter, supposing their densities the same, and as the squares of the distance, or 26,666 miles from the earth's centre. Hence the earth performs an orbit of that diameter, while the moon performs its own larger orbit.

OXONIAN.

Then of course the earth is, at the full moon, 26,666 miles nearer the sun than the true line of the orbit, and so much farther off at the new moon.

COMMON SENSE.

In truth, the re-action of the moon pushes the earth out of its orbit, as it recedes from the quarters.

That is, it pushes the solid earth, but the moving waters hang behind, if I may be allowed the expression, and rise towards the fulcrum. Being moveable they accommodate themselves to the centre of the forces.

OXONIAN.

It is a system of bodies acted upon by the solar force in the fulcrum, and the waters, as moveable, seek the centre of force, and endeavour to keep up the equilibrium of the system. Is this your meaning?

COMMON SENSE.

It is so; and you may perceive that as the fulcrum is necessarily in the line which joins the centre of the earth and moon, so the waters, in rising towards the fulcrum, appear to obey the moon; whereas the action is purely mechanical.

OXONIAN.

I see the whole. Then at the new and full, as the earth is at its greatest distance from its orbit, the tides are the highest, and so on, progressively increasing and decreasing, as it recedes from and approaches the orbit, or centre of force. Nothing can be plainer, if there were but one tide in 24 hours.

COMMON SENSE.

I am glad you have no other difficulty; I shall solve it by asking you a question. What becomes of the waters which the fulcrum has carried across the Atlantic and Pacific, and left on the western shores of those seas?

OXONIAN.

Why they fill the rivers and bays of America and Asia, and rise on the coast from 15 to 30 feet.

COMMON SENSE.

Well, the earth revolves, and the fulcrum, which they have risen towards, is carried over the lands of America and Asia. The power which brought them into that situation has departed: in other words a pendulum has been raised, as by the hand, which is removed; what becomes of the pendulum, and in the other case, of the waters?

OXONIAN.

I perceive that as the waters are thus accumulated on the western shores of the Atlantic and Pacific, and that as the force, or motion, which brought them there has departed, or varied its line of direction over other meridians, they are out of their due level; but how does this operate in producing two tides?

COMMON SENSE.

You are generally more rapid in your conceptions. Of course if they are left out of their due level, and are obstructed by land from following the fulcrum of the earth and moon, they must seek their level in the contrary direction, and oscillate back like a pendulum. A returning stroke, thus produced, might, in the first dozen tides, be irregular, but a thousand would produce the uniformity and regularity which we now witness.

OXONIAN.

I perceive it; they must swing back, and produce a second oscillation, or tide, as consequences of the first disturbance. The second tide seems, therefore, to be an accident arising from the introduction of tracts of land between seas, and this doctrine explains what I have read in some voyages in the South Pacific, where, as there is no complete obstruction of land, they have but one tide in 24 hours. It seems, therefore, that the fall of all bodies towards the centre of a planet, is owing to the two-fold motions of the planet. I am satisfied and instructed, while I am astonished at the simple mechanism by which this great result is produced.

COMMON SENSE.

What think ye now of *universal* gravitation?

OXONIAN.

I feel that it is nonsense rendered universal.

COMMON SENSE.

What think ye of the projectile force?

OXONIAN.

I perceive its utter irrelevancy, and consider it a monstrous project of the imagination.

COMMON SENSE.

What think ye of the vacuum of space, so necessary to the perpetuity of the projectile force?

OXONIAN.

I consider its introduction into philosophy as a libel on nature, and on the Omnipresent Deity,—and as affording proof of a vacuum in the heads of those who promulgated the doctrine.

COMMON SENSE.

But you libel the great Authorities in philosophy!

OXONIAN.

Better do so than libel truth, nature, and my own understanding!

END OF DIALOGUE I.

DIALOGUE II.

On Chemical Phenomena, or the Philosophy of Atoms.

OXONIAN.

YOU have turned Gas, or the medium which fills all nature, to good and proper account. It cannot fill all space, and as an intervening medium connect every thing without efficient powers. It is, you say, the means by which the bodies of the solar system act on one another; while, on a smaller scale, it equally operates between distant bodies on the earth. I should like to hear your opinion of the construction of this important agent, and of its mode of operation.

COMMON SENSE.

Your curiosity is reasonable, and though knowledge cannot be perfect in regard to an invisible agent, yet I will state the results of my considerations. In the first place, I wish you to bear in mind, that Gas is the universal lever of nature. She works with no other tool, and this tool diffuses forces, inversely as the square of the distances. Men, for purposes of expedition, and local precision, make use of fixed levers; but Nature, never in haste, operates universally by levers of gas. She moves the planets through it, and she works all her local and special wonders by its agency and activity. It is the connecting and continuous substance of all nature, and its structure accords with the multifarious results which it produces. Cause and effect are, in this case, as in all others, equal; or, in other words, action and reaction are always equal; though the varieties of matter, acting, and acted upon, often puzzle or confound our enquiries.

OXONIAN.

Great difficulties attend the investigation of atomic phenomena.

COMMON SENSE.

Man wants a sense for atoms; and the investigation of their laws and phenomena, without such sense, is similar to the investigation of colours by blind men, who, having heard of the phenomena of colours, should attempt to determine their nature, without an appropriate sense. The errors and perplexities into which they would fall, would be similar to those of the chemists. Theories, directing them into wrong roads, would be their chief obstacle, and their own sure guide would be the laws which prevail in regard to masses of which they have cognizance. It may be safely assumed, that nature works in the great and small by similar laws, and those of the former being understood, it will be less difficult to comprehend the latter.

OXONIAN.

I am listening; but I want to know what gas is? I believe the Germans gave it that name, from considering it as the ghost of matter, or of nature. Its most familiar example is, the air in which we live and breathe. The atoms of which it is composed, are considered, by some, as in a state of mutual repulsion, and modern chemists conceive that their interstices are filled with caloric.

COMMON SENSE.

I fear we are travelling again into the fairy land of hypotheses. Your philosophy of aggregates or masses was built on attractions, local and universal; these, I thought I had destroyed—and now you build your philosophy of atoms on repulsions and caloric. What evidence have you of the existence of one or the other?

OXONIAN.

Is it possible that you mean to deny the existence of such a power as repulsion, and of such a great principle as caloric?

COMMON SENSE.

I deny the existence of both, and regard them merely as pretty words, used as a cover for idleness or ignorance. The effects ascribed to them may be satisfactorily accounted for on general principles of matter in motion, in accordance with the universal simplicity and analogy of nature.

OXONIAN.

But what do we gain by change of names?

COMMON SENSE.

I am astonished at the observation, from an enquirer after truth, and an investigator of nature. Is it indifferent whether, in those characters, we ascribe true or false causes; or use terms which imply modes of operation unaccordant with the real operations; which lead to false trains of reasoning; and which, when applied to complicated cases, fail us, and oblige us to imagine new principles? But are the ideas meant to be conveyed by the terms repulsion and caloric, so clear and rational, as to render them worth retaining? How is repulsion performed? What is caloric?

OXONIAN.

I can only repeat the language of the schools; that atoms sometimes attract and sometimes repel one another, or are within each others' spheres of attraction and repulsion. In general, where attraction ends, repulsion begins. But, giving up attraction, I feel less confidence about repulsion, though the phenomena imply some such principle.

COMMON SENSE.

If the principle is absurd, we may feel confident that it does not exist in nature; and, instead of labouring to qualify it, ought we not, rather, to endeavour, as honest philosophers, to find out rational means of explaining the phenomena?

OXONIAN.

But there seems less difficulty in accounting for repulsion than attraction, if we suppose that, in all cases, caloric infuses itself between the atoms, and thereby separates them.

COMMON SENSE.

You do but attempt to explain a chimera by a supposition, in itself without foundation. What is the insinuating caloric?

OXONIAN.

The matter or principle of heat; the great discovery of Black, and the proud illustration of Lavoisier. It is, say others, one of the imponderable elements.

COMMON SENSE.

A very pretty nomenclature, calculated to delight the unthinking,—those who follow leaders like horses in a team. Is the term imponderable element to be found in Milton, or in the Arabian Nights?

OXONIAN.

A truce to levity. It ill becomes the subject.

COMMON SENSE.

It is a light subject: how can I refrain from accommodating my feelings to the subject!

OXONIAN.

Well; but do you deny the existence of imponderable elements? We have several of them, as light, caloric, electricity, and ——

COMMON SENSE.

—and moon-shine, I suppose!

OXONIAN.

I repeat, that your pleasantries are out of place.

COMMON SENSE.

You began the pleasantry by introducing your imponderable elements! I regard them as the climax of joking, or, philosophical hoaxing.

OXONIAN.

But how else are we to account for the phenomena? They afford reasonable explications, and it behoves you to prove their non-existence.

COMMON SENSE.

So, if I assert that there are planets in the shape of cocked-hats, am I to expect your credence if you do not prove the contrary? Don't you think there may be planets in the shape of cocked-hats?

OXONIAN.

I will answer no such idle questions, simply because, I think you mean to insult me.

COMMON SENSE.

I took your imponderable elements as no offence; why should you object thus to my planetary cocked-hats? Your answer will guide our argument.

OXONIAN.

Well, then; I believe there are no planets in the shape of cocked-hats, because I think them improbable.

COMMON SENSE.

And just for the same reason, I believe there are no imponderable elements.

OXONIAN.

But we discover them in the phenomena.

COMMON SENSE.

Now, then, it is my turn to be offended; take that. *(Giving him a blow with a stick on the hand.)*

OXONIAN.

Hold, sir; this is outrageous: you have made my hand smart. I have done with you.

COMMON SENSE.

I beg your pardon. My assault was on your understanding, not your person.

OXONIAN.

I expect an immediate explanation!

COMMON SENSE.

I merely intended to exhibit the discovery of a new imponderable element.

OXONIAN.

I wish you had kept it to yourself. I do not wish to discover elements at the expense of so much *pain*.

COMMON SENSE.

My purpose is answered, I have introduced you to a new imponderable element. *Pain* is, it seems, an element very sensible, and yet quite imponderable.

OXONIAN.

Very sensible, truly.

COMMON SENSE.

My stick contains an indefinite quantity of *latent pain*, which may be rendered *sensible* pain by blows or motion. Is not this your theory of caloric? It is latent in a body, like pain in my stick, till excited. Shall I give you another proof?

OXONIAN.

No, no! I want no more of your striking proofs. Pain, then, seems an imponderable element, latent in your stick.

COMMON SENSE.

I don't say that, nor mean it; but it is just as much so as caloric, and resides just as much in my stick as caloric in a piece of coal.

OXONIAN.

I understand you, but I wish you had adopted a more courteous method of illustration. Your imponderable element of pain still affects my hand.

COMMON SENSE.

I did but put the stick in motion, thereby exciting the latent pain which it contained, and then, by the blow, increase the capacity of your hand to receive it. Are not these the exact phenomena of your principle of caloric?

OXONIAN.

We are friends again; I see my hand was only the object of an experiment, to elucidate a gross absurdity.

COMMON SENSE.

You are a genuine philosopher, caring not for your sufferings in the cause of truth! Of course, there is no latent pain in my stick, more than there is latent caloric in a lump of coal; but my stick by its aggregate motion, was capable of affecting your nerves just as the coal, by atomic motion, would be capable of burning them. There is no more latent imponderable caloric in one, than there is latent imponderable pain in the other. The pain, in the language of the schools, was not inherent in the stick, but an accident of the stick; and just so, light and heat, (or caloric, as it is a pretty word, and you may like it better,) are mere accidents of the coal. Both possess capabilities, from the structure of their matter, of producing certain sensations and phenomena, but the result is produced by combining the capability with motion.

OXONIAN.

The error seems to consist, then, in confounding the result, which is a combined effect of the matter with motion, with the simple capability of the peculiar matter when subject to certain motions. In this sense only the matter of the stick contains pain, and the matter of the coal, light, and caloric.

COMMON SENSE.

Your inference is wrong: the stick contains no pain without motion, and, even, without nerves to be affected: in the same sense, it also contains momentum; and, if its atoms are duly affected, it also contains light and heat. All these are results of two several things, the matter, and the motions applied to it. There are no imponderable elements of light and heat more than there are others of pain and momentum.

OXONIAN.

As you contend for the materiality of light, and must assign to the atoms their known velocity, how has it happened that the most delicate experiments have never detected the momentum of light?

COMMON SENSE.

Because its action is by a succession of atoms, between whose motions, on the same spot, there are determinate intervals of time. If light moved by undulations or pulsations of the body of the species of atoms which produce it, or if it were a continuous propulsion from the luminous body, or if it consisted of identical rays in rectilinear velocity, we ought to be able to measure its momentum, by delicate experiments. But, from our being unable to detect any momentum, it is evident, that each atom of the radiating train moves through only an indefinitely small distance, too small, perhaps, to be measured, even if its entire motion were transferred to the object of experiment. Hence, the action cannot affect whole surfaces or masses, but only the superficial atoms of these surfaces, on which the action is separately expanded, and made to appear in the resulting heat.

OXONIAN.

Nevertheless, I am still perplexed about all those classes of phenomena by which small quantities of matter are made to occupy larger spaces; and cannot otherwise account for this effect, than by a principle of repulsion exerted among the atoms, or by caloric filling the vacuities.

COMMON SENSE.

But must not this caloric consist of atoms?

OXONIAN.

It is generally considered as an imponderable principle. But, if it exist, it must, of course, be atoms.

COMMON SENSE.

Close together, perhaps, that they may maintain the separation of repulsion. A plenum of calorific atoms, and without ponderability!

OXONIAN.

I cannot surmount the dilemma. Then there must be a repulsive principle among the atoms. Small atoms must flow, or emanate and act on the large ones, so as to drive them asunder.

COMMON SENSE.

Small cannon-balls, or little bombs, I suppose! What absurdities! Theories are like lies—a hundred must be invented to sustain one original invention. What pretty little artillery these *primary atoms* must be provided with, and with what exhaustless ammunition!

OXONIAN.

I feel the force of your ridicule; but how does a small body, converted into gas, fill a larger space?

There must be interstices, and how are the atoms kept asunder?

COMMON SENSE.

How is the conversion made?

OXONIAN.

By heat or caloric.

COMMON SENSE.

How is this produced? I mean, how is what you call heat, originally produced?

OXONIAN.

Sometimes by friction, and at other times by percussion.

COMMON SENSE.

That is, in all cases, by motions of matter.

OXONIAN.

It would seem so; friction and percussion are modes by which matter is moved.

COMMON SENSE.

If I strike a piece of iron several blows with a hammer what is the effect?

OXONIAN.

The iron becomes hot.

COMMON SENSE.

What renders it hot?

OXONIAN.

If I say caloric, I suppose I shall receive a blow?

COMMON SENSE.

Is not the motion of the hammer imparted to the iron?

OXONIAN.

No: the iron does not move; the motion of the hammer is lost and destroyed.

COMMON SENSE.

Motion lost, did you say?

OXONIAN.

Yes.—This is one of the instances of loss of motion. Newton tells us, that gravitation, attraction, and fermentation are means of keeping up lost motion.

COMMON SENSE.

But does he not also admit the old doctrine, that action and re-action are equal. If so, can any motion ever be lost?

OXONIAN.

But Newton assails this doctrine of the eternal continuity of motion.

COMMON SENSE.

Newton had an opposite theory to maintain. He created a relative motion of two bodies round a fulcrum, and then applying an *absolute* motion to the fulcrum, he contended, that the change of position in the bodies, *relatively* moving, caused a variation of *absolute* motion. It reminds me of King Charles with the fish alive, and the fish dead; and confounds the *relative* motions which take place on board a sailing ship with the *absolute* motions of the ship in space. He might as well have said, (the resistance of the water out of the question) that there is more motion in a ship moved endways, than in one moved sideways. The whole was an ingenious sophism to support his obscure causes of gravity, fermentation, elasticity, and animal-will.

OXONIAN.

Nevertheless, the motions within a ship are motions, and I agree with Newton, as in his balls, that there must be more actual motion when a ship is full of living moving bodies in concurring motion.

COMMON SENSE.

The sophism arises from not distinguishing between absolute and *relative* motion, and considering the source of the latter. There is but one quantity of motion concerned, that is, the absolute motion of the ship, whatever be the cargo. The interior motions are derived from it. If a man walks or runs in the ship, he deflects part of its motion with one foot, and returns it again with the other. Nothing is gained or lost. So, if one give a man a box on the ear, the motion is derived from the action of the foot against the ship, and returned to it through the head of the person struck. He suffers as much as though it had been absolute motion, because it is such deflected, his sensitive ear being made the passage of its return to the ship. The ship's motion is a total, the others are parts of that total, but so instantly returned as not sensibly to affect the phenomena of the total. A ship, as part of the earth, is subject to its motion; but the subordination of falling bodies in a ship to the motions of a ship, afford collateral proof that the entire fall is altogether a phenomenon of motion.

OXONIAN.

Is not motion lost, when a body, by two forces, describes the diagonal of a parallelogram. Wood, Emerson, and all the authorities agree in this.

COMMON SENSE.

No! for force is motion, and is only transferred entirely when entirely obeyed: the proposition is a contradiction in terms. Both forces, by the hypothesis, operate obliquely, and, in consequence, the body moves from them in the diagonal. The forces cross and counteract each other; and either produce, or are capable of producing, other motions. The body is, therefore, the patient of only part of each force, and obeys that part of each. To suppose that the body is impregnated with the total of both forces, and that part of each is lost in the diagonal, is to consider motion as a substantial quality; whereas, the forces are quite independent of the affected body, and the actual motion or force, which the two oblique forces transfer to the body, is represented by the diagonal. The body could not move along either base or perpendicular, while *both* were acting on it, and, therefore, to compare these with the diagonal is a gross absurdity. If the case were tried with billiard balls, the striking balls would be deflected, and continue to move till they had parted with the remainder of their motion.

OXONIAN.

But, recurring to our experiment, the hammer was in motion, it stands still; the iron does not move, and motion in this case seemed to be lost.

COMMON SENSE.

Part of the motion was returned to the earth; but suppose the hammer had struck a tile, instead of a piece of iron?

OXONIAN.

Why, then the tile would have been broken, and scattered in fragments.

COMMON SENSE.

Or, a piece of iron at a white heat?

OXONIAN.

Then the scales would have flown about.

COMMON SENSE.

Can't you conceive the cause?

OXONIAN.

It appears, that the motion of the hammer is transferred to those pieces.

COMMON SENSE.

Do you think, then, the motion of the hammer was lost because it struck the adhesive mass of iron? The tile, which palpably distributed the motion, did not become hot; while the iron which did not change its place, and distributed no visible motion, became hot.

OXONIAN.

I perceive your meaning. The motion was carried away by the parts of the tile; but, in the iron, as the mass does not separate, the motion is invisibly radiated, by atoms of the iron; or perhaps the atoms in the interstices of the iron are thrown into intense vibrations.

COMMON SENSE.

Doubtless it is so; and if we strike the iron till it is hot enough, we shall make the radiating atoms, or propulsions, visible in red light; or in atoms small enough to permeate the coats of the eye, and affect the optic nerve; or, we shall affect the surrounding gas with such intense pulsations, as will even produce a sensible operation on the nerves of the eye.

OXONIAN.

I am pleased with this explanation, but have you no other means of corroborating this doctrine?

COMMON SENSE.

Yes, plenty: take any unadhesive substance, as water, put it on the hot iron, and the radiating or moving atoms of the iron will affect the water, separate its atoms, and form aqueous gas: part of the motion of the hammer being then, actually, in the atoms of water.

OXONIAN.

As the heat of the iron is abated at the same time, this seems highly probable.

COMMON SENSE.

Well, then, here I have made a drop of water fill a hundred times its space; and, if my apparatus were more elaborated, I could confer on it all the expansive powers of steam.

OXONIAN.

Your atoms, I perceive, are in motion, and possess, in part, the momentum of the hammer. But atoms so excited ought to fly off into space, whereas, these become localized, and fill only the adjacent limited space. Why do they stop?

COMMON SENSE.

When they were evolved from the iron, did they move into a space, empty or full?

OXONIAN.

Full of aerial gas, no doubt. Of course, they were evolved into the space, filled with the adjoining air.

COMMON SENSE.

Good; and this air compresses equal to fifteen pounds to the square inch; consequently, it is gas, or gaseous atoms, acting against new evolutions of similar atoms. Must not the new atoms, as they rise one after another, strike against, and be continually deflected by the others, turned whichever way they may?

OXONIAN.

It seems so; but continual deflections would drive them into CIRCULAR ORBITS.

COMMON SENSE.

This is precisely the result, at which I proposed you should arrive. Whenever gas is created, some great motion, as that of a hammer, direct or indirect, proximate or remote, must be communicated to suitable atoms. These radiate into space already full; they are there necessarily obstructed and deflected, till they form themselves into orbits, filling a space greater or less, according to the original momenta transferred to them.

OXONIAN.

This is so plausible, that I can urge nothing against it but its novelty. Hence, space is filled with the *power* of these revolving atoms, which, in revolving, occupy a determinate area by their momenta, and drive away other atoms from the same space. If it be so, then we have no occasion for repulsion to form gases, nor for caloric to fill the interstices. Atoms seem, therefore, to move like planets. I see no reason to the contrary, and the doctrine accords with, and seems to explain all their phenomena. Sceptics will, however, divert themselves at the idea.

COMMON SENSE.

Fools always laugh at their own conceits. Don't you know, that the doctrines of the earth's rotation and annual orbit were, at first, treated as highly ludicrous, and, at once, as improbable and impossible, as impious, and contrary to Scripture? My conclusion is not drawn from analogy, but from the relations of the atoms evolved to other atoms, and from the actual phenomena; yet the analogy is a confirmation, and, in general, we can only reason by analogy from things seen to things unseen.

OXONIAN.

But the phenomena in the heavens are simple, and those of atoms seem complex and contradictory.

COMMON SENSE.

Only because we look to the ends of a series of phenomena, and view the ultimate effects of a multitude of combined causes, which, thus blended, we cannot separate. Before the motions of the earth were understood, men saw bodies fall, and called that tendency weight; and, then, as a short road, ascribed the weight to *weight*, or to the philological fraud, gravitation. The weight was an ultimate phenomenon, like many of those in chemistry, and, like those, never could be explained but by higher abstractions. The chemists, hitherto, have been like flies on a window; they fatigue themselves to death by ranging one pane, though the window is half open. Nature operates by general laws, and these are not to be deduced from isolated facts, which are results of a combination of laws. We must reason downward, not upward; at any rate, if we must analyze, we should also synthetize.

OXONIAN.

But how do you explain the phenomena of varied volumes connected with varied heat?

COMMON SENSE.

Thus: as in cooling the iron, expansion was created by received motion; so, in compression, motion is parted with, and adjacent bodies are heated. Heat, therefore, is nothing more than atoms in motion, and there is no heat *per se*, i. e. no caloric; but heat is merely a result of concentrated, or reiterated, and accelerated, atomic motion. Thus, there is no heat in light; but the atoms in motion, by reiterated impulses on the surfaces of opake bodies or on their atoms, put them into that motion which we call heat. You will feel, also, that if, after thus creating gas, you suddenly compress it into its original bulk, it must part with its acquired momenta, or, in the language of the chemists, give out heat.

OXONIAN.

But the subject is one of great complexity and variety.

COMMON SENSE.

Render it as complex and various as you please, you must always arrive at the same result. Varieties arise from the various matter acting and acted upon; and, if honestly examined, must, nevertheless, accord universally with the general laws.

OXONIAN.

Hence, then, we appear to live within a world in motion, or in gas in great energy of motion. I am astonished at the boldness and originality of the idea. Thus motion is every where, and we trace in this ubiquity of motion, the surprising activity of nature?

COMMON SENSE.

Don't you perceive in it the sources of ANIMAL HEAT, STRENGTH, and MOTION? An animal is a self-acting lever, deriving its powers as a lever, by fixing gas in which it subsists, and its motion, by acting against the earth. All the motions of its superior limbs are derived from its lower ones by this action; and the power of its lever, to act against the ground, is derived from gas-fixing. A man, when falling from an elevation, may breathe and have energy, but without re-action he cannot lift his arm.

OXONIAN.

This is very clear. I perceive now, whence I derive my strength, and why my muscular lever is vigorous. The earth is in motion, and I am enabled to appropriate part of that motion by the energy of my muscular lever, which again derives its own energy from gas-fixing. We are like men in a moving ship.

COMMON SENSE.

Gas is also the source of animal heat, which is atomic or gaseous motion transferred during inspiration, by fixation in the cells of that singular structure, the lungs, and carried away by the blood.

OXONIAN.

But would not moving gas be without weight, or downward pressure?

COMMON SENSE.

The weight would be less than its true density; but the motions of the earth would nevertheless prevail; that is, it would have weight so high as it is involved in, and is patient of the two-fold motions of the earth. It would then fine off, both in motion and density, into space. Remember, that there is no weight *per se*, and hat all specific gravities are owing to common velocities being applied to various densities, or structures of matter. Weight is the mere effect of impulse in a direction at right angles to the test of weight. A stone is heavy in a perpendicular direction, while descending, or endeavouring to descend, to the earth's centre; but a cannon ball is heavy only in an *horizontal* direction, when so projected from a cannon. Both are mere consequences of impulses; the first, of the earth's motions, and the other, of the exploding gunpowder.

OXONIAN.

As bodies in motions contrary to the direction of centripetal motion are proportionably less the patients of this motion than if they were at rest; i. e. a cannon ball projected from a gun loses for the time, all its centripetal motion, so it would seem that the motions of gaseous atoms would tend to diminish their centripetal force.

COMMON SENSE.

I perfectly agree with you, and have no doubt that from these circular motions every solid converted into free and unconfined gas, exhibits much less weight than in its solid state; which gases contain therefore, a far greater number of atoms than their specific gravity indicates. This perfectly accords with the obvious plenitude of gaseous atoms, and they could not, if not more numerous than is indicated by their specific gravity, perform their minute miracles, and fill with intense power spaces almost infinitely small.

OXONIAN.

Do the causes which evolve gas appear to be sufficient to create such universal motions ?

COMMON SENSE.

The causes are in the sun, in the solar light and heat, in every animal motion, in the atomic circulations of all vegetables, and in the oscillations of the ocean. Remember that space contains nothing but these atoms ; that, in other respects, it is a vacuum ; and that, except so far as they may fix each other by collisions, they are adapted in such free space, when once in action, to move for ever, and hence their apparent permanency.

OXONIAN.

The momentum of a hammer, I perceive, transferred to minute atoms of iron, must confer on them an enormous velocity ; and as the means of evolution are so numerous, is there no danger on the other hand, that all the volatile matters of the earth may, in due time, become gasified ?

COMMON SENSE.

There is such danger. It is so in the sandy deserts of Africa, and is more and more so in parts of Asia, once renowned for their fertility. The God of Nature has, however, formed a counterpoise in the gas-fixing powers of the useful myriads of living creatures which cover the earth. These refix the gas, and return to the soil the constantly evolved gas, for manure, by their bodies, evaporations, and excrements. Vegetation does the same ; and thus every generation of both, provides subsistence for those that follow.

OXONIAN.

I now discover why more heat, or more atomic motion, rarefies gas, by enlarging the momentum, and increasing the radius of every orbit, thereby rendering the bulk more rare; while, in this varied springiness, and in the motion of their orbits, I am able to account for many phenomena. But, as gases consist of atoms performing orbits, what are the peculiar circumstances of liquids and of solids?

COMMON SENSE.

Varieties of atoms possess fluidity, in proportion to their facility of motion. Thus, a slight quantity of motion keeps atoms of some forms from fixing or crystallizing, while others require a larger quantity; and this effect is sustained by the regular interstices being filled with gas. Lessen its motion by contact with colder bodies, and the intervening gas becoming fixed, the atoms crystallize. Solids have parts united in continuity, and dovetailed, as it were, together, but fluids consist of disunited atoms floating in gases. To render the latter solid diminish the gases, by more motion, as in boiling; fix, or extract them, by the contact of cold bodies, or by exhausting a receiver containing them. The whole is merely varied matter and motion. Whenever a body changes its state, it either receives motion, or parts with atomic motion.

OXONIAN.

Hence, if I inspire some gas, and it becomes fixed or compressed in my lungs, heat must be the consequence of its parting with its motion. Motion and heat parted with, must in this case also confer motion and heat, while increased breathing must confer strength. Have I lived in this *moving world* so long, and been insensible that I derived from it all my heat and energy ?

COMMON SENSE.

It seems so. Did it never before occur to you, how essential this gas was to all your functions ?

OXONIAN.

Never : I have been in a cloud of errors. I have been content with such phrases as vitality of air, principle of life, breath of life, calorific principle, life of the blood, &c. ; and, blinded by such terms, never examined further. I see clearly, that if we close an animal's mouth and nostrils, that he ceases to live ; that he inhales and fixes gas in proportion to the exercise or exertion he makes ; and that he perspires or exhales in the same proportion. This gas-fixing must occasion FEVERS, whenever the simultaneous evaporation from the skin is checked.

COMMON SENSE.

When evaporation by the skin is checked, heat must be accumulated and accelerated, by simple breathing ; while the increased action of the system must, in various constitutions, habits, and local affections, create all the varieties of fever, and diseased local affections of morbid parts. Their gross ignorance of the simple origin of animal excitement, leads to so much empirical practice among the faculty.

OXONIAN.

But experiment proves that we do not fix the whole volume which we inhale, but only the oxygenous part, and that we expel a compound. In like manner, during the heat evolved by combustion, oxygen seems fixed, and compounds evolved. The progressive fixation of the oxygen seems, in this case, to be obviously the cause of the *continuous* heat of a burning body.

COMMON SENSE.

You are right; for if an animal and a candle be put under two close receivers, they will both expire as soon as they have fixed the oxygenous part of the gas; and the residuum, in both cases, will be the same, or nearly so. The animal and the candle will then require the blow of a hammer to revive them.

OXONIAN.

Revive them, by knocking them in pieces!

COMMON SENSE.

No, I would administer the blow by suitable interventions. I would first give it to a piece of iron, then transfer it from the iron to some black oxyde of manganese, producing oxygen gas.* This I would convey under the close receivers, and instantly the wick of the expiring candle would begin to blaze, and the animal to jump about. The blazing and the jumping would be the continuous motion of the hammer transferred; and as long as any of it was not appropriated, both sets of phenomena would necessarily continue.

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* In such case, a paste made of the oxyde and sulphuric acid will answer better, but the principle is the only point in this discussion.

OXONIAN.

But why do the candle and the animal fix oxygen?

COMMON SENSE.

The result arises from the opposition of the relative gaseous powers concerned, and this contrast is necessary, because similar powers, or atoms, would produce no phenomena. Combustibles are, perhaps, necessary constituents of flame, simply because their atoms are the smallest, or rarest, and, therefore, the most easily affected by friction, percussion, or the fixation of oxygen. No combustible burns in hydrogen; because relative powers in the gases concerned are necessary. One must be the base to fix the other; and without contrast of power no change could take place. Burning is the fixation of the gases combined. The whole of combustion is the mere receiving of motion from atoms called oxygen, which, in this process, become fixed by union with the gaseous combustible.

OXONIAN.

What is the matter of light?

COMMON SENSE.

Light is not an imponderable substance, nor an element *sui generis*, but mere propelled atoms. As light, it is not substance, but light consists of certain atoms propelled by the action and re-action of the gases and carbon. These produce the phenomon called light by affecting trains of atoms situated around; and the accompanying heat is the result of the reiterated and accelerated actions of those atoms on atoms at the surfaces of bodies. Identical atoms of light are not propagated more than identical atoms of sound. The atoms are subject to a different action, and act on a differently constructed sense, but the propagation is similar. The identical atoms are not themselves diffused, but merely act on adjoining atoms, propel them, and these others. Is it not more rational to consider them as affecting trains of atoms all around, than as travelling identically, and forcing their feeble way through fixed atoms? With respect to transparent media, as glass, water, air, &c. their very name explains their power. Atoms of light exist in all such media. They are excited at the surface to which they lie parallel; and refraction, when incident atoms fall obliquely on the surface, is a consequence of their being affected by a new force in a different direction.

OXONIAN.

The theory is plausible; for when the motion, as in diaphanous structures, is transferred to the atoms within, heat is not produced; but when it is transferred to the surface of opake bodies, heat, or atomic motion, is created. The laws of motion seem as palpable in these phenomena as in others. Yet it appears to me, that after the cause, or first motion, as the striking of a flint and steel, is expended on the hydrogen, the effect ought to cease, yet it continues as long as any hydrogen is to be found in contact. How is this?

COMMON SENSE.

Your question is pertinent. It continues only as long as oxygen, or other similar supporters of combustion, continue to be fixed. If the carbon evolved, as on a large surface, obstructs the access of oxygen, or if the flame be put under a close receiver, and oxygen has no access, it expires as soon as the contained oxygen is fixed. Oxygen, therefore, is necessary to the *continuity* of flame. In being fixed, its atoms part with their momenta, and this action is requisite to maintain the evolution of hydrogen. The experiments on the heat-conducting powers of gases, prove the great sensibility of the hydrogen gas. It is 2½ times greater than the other gases, and I conclude, therefore, that its circles of rotation are enlarged in proportion. Conducting heat is merely receiving atomic motion.

OXONIAN.

I am at once satisfied and gratified. I see the use of oxygen as a *continuator* of the first excitement, and the oxydation of a combustible proves that the oxygen is combined; or, mechanically speaking, that which was previously in motion has become inert, and has parted with its motion. But how does light pass through air, glass, &c.

COMMON SENSE.

A clear exemplification of the effect of calorific, or heat-making trains of atoms, takes place when we interpose a plate of glass between ourselves and the fire. The colorific and visual trains first communicate their action through it, but those which are of largest bulk are a considerable time in progress. That is, the glass continues at once the train of small atoms, but it requires reiteration to affect its opposite side, in regard to the large ones. Whence I infer, that as the large ones emanate from the opposite side, by continuity of action, that the smaller ones also emanate from the glass; and that the identical atoms which flowed from the fire, do not pass through in either case, but merely affect similar atoms previously existing within the glass, but at rest, till excited. Hence the powers of coloured glass. It is transparent, yet no colours emanate but its own. Nothing can more palpably demonstrate that there is no transmission of identical rays. They arrive at one side of the glass, affect within it such atoms as it contains; these affect others next the glass on its opposite side, and such is transmitted light; but if the glass is only of one colour, then that colour alone is transmitted, for it is the only one which prevails within the glass.

OXONIAN.

Yet light pervades a vacuum.

COMMON SENSE.

First prove that you make a real vacuum. You produce a rarefaction of elastic gases. But the very exhalation of your materials prevents any real vacuum. We tolerate relative negatives in algebra, but an absolute negation in nature is an absurdity *per se*.

OXONIAN.

It has appeared to me, that, as I am able, by pressing the corner of my eye in a dark room, to produce, on the optic nerve, flashes of light, and all the prismatic colours, that light itself must be a mere mechanical affection. I have also experienced similar effects in the dark, when my eye has been diseased or inflamed, and these facts confirm your doctrine. But flame is not always of the same colour and intensity.

COMMON SENSE.

Flame generated without carbon, or some other such matter, is faint and rare, and, perhaps, even then, owes its appearance to the carbon in the volume of the combined gases. Heat is owing to the gaseous condensation, or to the motion parted with; and flame arises chiefly from the simultaneous separation of carbonaceous atoms, or fixed and compounded gases, which, receiving the motion, separate or explode, and thereby propel the atoms around.

OXONIAN.

You mean to say, that it is more easy for part of the momentum of a billiard ball to be conveyed to a distance by its action on a train, lying in straight lines, than it is for an identical ball to find its way through a chaos of balls, which may be spread over the table: consequently, that the identical atoms excited in flame do not travel to great distances, but merely act on trains of others. This notion certainly accords with the transmission of the effect, through dense diaphanous bodies. The only conditions are, that they should contain the species of atoms in action, and that their structures should permit the continuous action from atom to atom, within the body. There is then, in truth, no difference in the action of light, from diaphanous air, water, or crystal, and the effects arise from one and the same cause,—a train of atoms, acted upon within each, excited by incident atoms from without.

COMMON SENSE.

Nothing can be more preposterous, than to suppose, that any atoms, especially such as the minute ones of light, could perforate in straight lines, either the atmosphere, water, glass, or the coats and humours of the eye! I repeat, that atoms of light do not diverge more from flame than atoms of sound from a vibrating string. The whole of the phenomena of light is better explained by considering it as affected trains of atoms, whose radiation renders their intensity inversely as the squares of the distances.

OXONIAN.

I have always been confounded by the doctrine of identical atoms traversing solid media with the known rapidity of light. But, that the materials of light exist in bodies, is rendered evident by their temporary phosphorescence; and even by the phenomena of double refraction, a mere effect of disturbance within a body having a peculiar structure. The very notion of an incident ray being split into two parts is ludicrous. Considering, too, that the atoms, capable of being affected, lie parallel to the surfaces, we then comprehend, at once, the action of refraction.

OXONIAN.

How do you explain the deflagration of the gases, or of combustibles and supporters?

COMMON SENSE.

To ignite them, I connect them with, or make them part of, some other flame; for all flame is a case of gaseous ignition. The two gases are conductors, or supporters of inflammation; and if they are carried to a flame, or flame to them, they become, while both the gases are present, a joint continuator of the flame by mutual fixation.

OXONIAN.

But what is the deflagration itself?

COMMON SENSE.

All deflagration and combustion is mere gaseous condensation. Gases are atoms in form and motion, producing various momenta, and their combustion is a phenomenon, and always a case of condensation. During the reduction of volume, atomic motion, or heat, is parted with, and received by other bodies, and hence this part of the phenomena. In another point of view, it is a species of crystallization, the gas being converted into a liquid, nearly as a liquid itself is converted into a solid; but as the change of volume is much greater, and the original motion much greater, so the heat or motion parted with is much greater.

OXONIAN.

Your answers are very clear, as far as they go; but what is the mechanical means by which the sudden condensation takes place?

COMMON SENSE.

It is sufficient to the purpose of my principles, to shew that the phenomena arise from mere mechanical condensation, and reduction, of volume. Many means, however, may be conjectured, such as the following, viz. the motion applied, or the ignited body, drives atoms out of their orbits, by which their relative arrangement and orbicular force being destroyed, the surrounding gas simultaneously rushes in, and combining, forms a liquid. I consider oxygen as the name of gas in a certain degree of relative activity, and that the undue excitement of the hydrogen disorders the correlative motions of the two, and creates more space than matter, which latter the oxygen supplies. They have motions in mutual relations, and an affection of one, affects the other.

OXONIAN.

Of course, during this condensation, all the motion which existed in the volume of gas is parted with to the next adjoining bodies, and hence the heat of the process; but how do you account for the light which, with various intensity, accompanies the condensation?

COMMON SENSE.

If a volume, of a cubic foot in bulk, is suddenly condensed into the tenth of a cubic inch, and the gas in the cubic foot is converted into the tenth of a cubic inch of liquid, of course all the other atoms within the same sphere must suffer an intense propulsion, and *be squeezed out,* as it were, with great atomic force. Nor would this effect be limited to foreign or non-gaseous atoms alone, for part of the atoms of the gases would be involved in the radiating action, and the whole would produce the mixed effect called white light.

OXONIAN.

Of what nature do you consider the atoms thus affected by the condensed gaseous volume, and so producing light?

COMMON SENSE.

Besides the atoms of the condensed gases, all of which, it may be supposed, would not be combined in the liquid, I conceive, that the atoms called carbonaceous, would be those chiefly affected; and this agrees with the intensity or whiteness of light, which, it is known, depends on the quantity of carbon, a defect yielding blue light, and an excess, red light.

OXONIAN.

I think I understand you. The important phenomena of combustion consists in the condensation of the gases concerned, from large volumes of the gases to the small one of the resulting liquid, hence the heat; while the flame and light is a sult of the pressure of some of these atoms, an carbonaceous atoms, from within the space in w the gases previously existed.

COMMON SENSE.

You have expressed my views, as far as I h gone already, but I will illustrate them with an ample. By violent collision, or excitement of ato motion, I get my first light, either from the perc sion of a flint and steel, or by friction, and my ob is to excite by the motion or heat, the connec hydrogen, or other combustible gas, into great undue motion. Having effected this, the action motion of the hydrogen disturbs the near oxyg which, losing its previous motion, unites with hydrogen, the compound atoms being perhaps t too large for the impulse, or not adapted to perfo the regular gaseous orbits. The surrounding presses inward, and completes the union. Cond sation follows, and hence external heat is distribut The flame is the simultaneous result of the co pression. Atoms are pressed out, as it were, by condensation; these affect other atoms around, whi again affect trains to great distances, and hence t affection called light.

OXONIAN.

This illustration applies, however, merely to y exciter:—How do you transfer the energy of t citor, and maintain combustion for practical purposes?

COMMON SENSE.

Having generated my first flame, I am able to propagate it by bringing it into contact with similar gases or materials. If light is my object, these materials must be combined with the essential ingredient of carbon. Hence, the adoption of animal fat or oil, or carburetted hydrogen, all combinations of carbon with hydrogen. I then carry my prepared excitor, as a match for example, to the wick of a candle, transfer its atomic motion to the wick; this evolves and excites the hydrogen, which disturbs and fixes the nearest oxygen. The previous volume is reduced, and heat and light are produced, and continued as long as any oxygen is present, or any hydrogen remains to be evolved. The oxygen and carbon combining, from what is called, carbonic acid, the oxygen and hydrogen form water, and the propulsions constitute radiant light. I have only guessed at a reason why hydrogen disturbs and fixes oxygen, but no doubt it arises from the law of their relative motions when combined, being destroyed by the excessive action imparted to the hydrogen.

OXONIAN.

But polarity of light is a difficult subject.

COMMON SENSE.

To support my system, it is not necessary I should account for any thing which is not contrary to it.

Polarity is a special direction, created by special resistance, and simply proves that space is not filled with a chaos of atoms; but that they range themselves in absolute and relative order, or trains; and in the special direction of those trains re-act on other atoms, which are moving through them, and thence produce polarity.

OXONIAN.

Do these notions of your's correspond with some of the peculiarities recorded by Newton, in regard to his coloured circles, which prove vibration, or what he denominates, fits of easy transmission and reflection? Euler and others insist on the doctrine of vibrations, and they accord with many phenomena.

COMMON SENSE.

In every case of flame, it is to be supposed that the radiations are not taking place at every minute part of the surface, but that they are simultaneously distributed. Hence, the radiations affect different trains of atoms on every side; and after a train has received the action, and continued it through a certain distance, a small space of time elapses before that train is again affected (if at all), during which the atoms re-adjust themselves, in their previous or usual state. This re-adjustment or re-action produces an effect like vibration, and accounts for Newton's fits of easy transmission and reflection.

OXONIAN.

Do you agree with Haüy and others, in thinking that there are only a definite number of primitive forms of atoms?

COMMON SENSE.

Haüy has considered forms, and results of forms, instead of power; for, I think that atoms have been contrived so as to produce a plenum of power in space, and the greatest power in the smallest space, and, therefore, were formed in subservience to this purpose. The forms and densities adapted to fill space with power, by motions at once universal, and interfering in the least possible manner, constitute the character of primæval atoms. Economy of space, in regard to power, is like economy of space in a bee-hive, and the omniscient architect of the universe, who sought to display the greatest power in the least space, has, doubtless, contrived the atomic agents of his power on this principle. For great motions, and as agents and patients, spherical atoms, doubtless, exist universally, and, as sluggish patients, doubtless, the cubic also. Varieties and compounds of these, positive and negative, in regard to facility of motion, constitute the system of atoms. If they were all of one form, common motions would produce no phenomena.

OXONIAN.

The chemists develope as active principles, oxygen and nitrogen, and they also assign independent existence to carbon, sulphur, phosphorus, with the metals, and some others. Oxygen and hydrogen form water; oxygen and nitrogen, atmospheric air; ni-

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trogen and hydrogen, volatile alkali, or ammonia. Hence, then, we have, in a permutation of those substances, mixed in certain proportions, the great results of water, air, and alkali. Then we have the metals, and also carbon, sulphur, boron, silica and the earths. What do you say of the atomic forms, of these forty-five or fifty elementary bodies of chemists?

COMMON SENSE.

I believe most of them are compounds, and that, in due time, they may be analyzed. It is not to be supposed that any miracle exists for the sake of such peculiar substances as sulphur, phosphorus, boron, and the like. In regard to the metals and earths, their similarity and dissimilarity concur in proving them compounds. To compose the whole, the chemists call for more primæval forms than an atom is susceptible of assuming. They can escape from the dilemma only by considering most of them as compounds, in which atoms are combined, of which they have not yet found a test. I am not willing to entangle myself in the labyrinths of chemical theories, but I doubt whether we can ever approach primary elementary atoms. In regard to the phenomena with which we are concerned, we may, nevertheless, consider some atoms as elementary. In point of fact, we come into contact, in the constituents of atmospheric air, with the atoms which support animal life, in its smallest forms; yet I do not consider it certain, that in the gases extracted from the receiver of an air-pump, we descend to the substratum of atmospheric air. The action is merely relative, and the exhalation of the materials out of the question. I cannot help suspecting that we obtain no real vacuum by any means which we ever can adopt. Light and magnetism are tests of something still remaining.

OXONIAN.

You admit that oxygen has great relative powers, when active in gas; has it the same operative powers when combined in solids, and at rest?

COMMON SENSE.

I conceive not: when at rest, it cannot have the same ratio of power relatively to the others, nor a power exactly similar to its own power in activity; so, also, in regard to the other forms of atoms, when gaseous, and when fixed. A lump of fixed acid has not the same activity as the same atoms in a liquid or gaseous state. Hence the wonderful variety and apparent contradictions which perplex chemical enquirers, from their not considering motion as an adjunct of the atoms, and as an essential element of all phenomena.

OXONIAN.

In addition to this doctrine, about the motions of the atoms, to account for their filling more space, as gas, than as fluids or solids, some account seems necessary of their Qualities, for they evidently have different qualities.

COMMON SENSE.

You mean different Effects, not Qualities. Matter must always have the same general qualities, though atoms of one kind may produce different effects on atoms of another kind.

OXONIAN.

What! do you mean to deny that there are different qualities, as acidulous, alkaline, &c. &c.?

COMMON SENSE.

Certainly, I do; I deny all properties or qualities, *per se.* What you call qualities, I call effects of various motion, applied to the same atoms; or, effects of the same motion applied to different atoms; and, even these effects are not absolute, but merely relative between the atoms.

OXONIAN.

This seems only a play upon words: what do you mean by the same atoms, and different atoms?

COMMON SENSE.

I mean simple, or primary atoms, of different forms, or compounded atoms, of various forms and density; and that these affected by similar or different degrees of motion, will, relatively to one another, produce all your qualities?

OXONIAN.

Still mechanical! But, surely, some bodies or atoms have absolute or inherent qualities?

COMMON SENSE.

Universally, in living and in dead matter, or, with reference to animation and chemistry, atoms act only on atoms; and, duly to operate, nothing is wanted but powers in one proportioned to those in the other. It is action and re-action in the atomic, as well as in the visible world. Atoms produce solids by simple union, in subserviency to their forms; gases by motion, and its effect on different forms; and liquids by the distribution of regular solids in gases.

OXONIAN.

But in maintaining the idea of relative momenta in atoms which fill space, you confer various power on the very same atoms, dependent merely on the direction of their orbits. Have you considered this?

COMMON SENSE.

I have not been insensible of this consequence, but have been unwilling to entangle my principles with random conjectures. The enemies of truth would seize on my conjectures as my principles, and caricature the one instead of answering the other.

OXONIAN.

But, taking it for granted that gases are the revolutions of atoms, it would be possible almost to demonstrate the results of their absolute and relative actions, arising from their planes of motion.

COMMON SENSE.

Doubtless, it would appear, that when any surface is opposed to atoms revolving in the same plane, the action will be less than when the rotation is at right angles to the plane; and will be attended with intermediate effects, when obliquely revolved. Change in the direction of action in the same atom might produce the varied effects of different atoms in that direction. I have often thought that, as polarity proves arrangement, and as arrangement seems a necessary condition, that many phenomena result from changing, by some appropriate action, the direction of the rotations of the atoms. They seem, as it were, to *face about*, and move in masses, like the military evolutions of bodies of men, or like the shutters of a Venetian blind, in mutual and extensive dependance, one mass on another.

OXONIAN.

The sudden transitions which we witness, the actions of electricity, and many circumstances, with which operative chemists are familiar, render this notion worthy of some consideration. We thereby narrow the number of atomic forms, and relieve space from many incongruous principles.

COMMON SENSE.

The adjuncts of various degrees of transferred motion, and of various directions of motion, seem to render fewer forms necessary; but I must leave these speculations to others. I am content with having directed attention to them, and am unwilling to commit my general principles, by reasoning about phenomena of indefinite divisibility, which are as wonderful and incomprehensible as infinite extension. Nevertheless, I contend for the analogy of causes in the minute and the immense; and am convinced that we now know so little, because this analogy has not been respected. I repeat, that all phenomena, whether in a cluster of millions of atoms in a grain of sand, or of millions of fixed stars, are regular results of atoms, fixed, or in various relations and motions.

OXONIAN.

I am perfectly sensible that such considerations can only be incidentally applied, but they merit notice; for your new doctrine of atomic rotations and momenta puts a new face on this curious and intricate department of nature. The old belief that inert atoms possess various qualities *per se*, are kept asunder by repulsion or caloric, and have no character but different forms, yet producing such various phenomena, left the mind unsatisfied; but the intense activity which your system assigns to the whole, illustrates their varied powers, while their relative motions are the necessary cause of their regular mixture in definite proportions.

COMMON SENSE.

The interesting facts so accurately developed by Dalton, Berzelius, and Thomson, relative to definite proportions in gases, fluids, and solids, require relative definite Powers in the atoms, such as would result from any common motion applied to various bulks; and also different Forms, which, in fixing, would fit one another. The varied definite results of motion, are not sufficient to account for the phenomena of solids, without the simple and compound forms of atoms. Common motions applied to these forms, and the momenta being variously directed, and, therefore, in various operations, likewise account for all those phenomena of gases which, though so close to us, are, notwithstanding, as far removed from our powers of accurate comprehension, as the phenomena of the most distant of Herschel's clusters.

OXONIAN.

Oxygen, however, appears to possess very efficient properties.

COMMON SENSE.

No properties, but such as are relative to the other kinds of gas, and which may result from the form of its atoms, or their excited motions. We discover that, in all cases, oxygen follows motion, or conductors of motion, while its co-extended gas (azote or nitrogen) remains passive; and these contrasted powers, resulting from their forms or density, cause many phenomena.

OXONIAN.

How can you explain the melting of metals?

COMMON SENSE.

It is the contained gases which expand solids, when heat or motion is imparted to them. Every pore is enlarged, and every fibre stretched by the expanded circles of the gas within the pores. If the heat is kept up, the parts of the metal explode, the gases mix, and form a fluid; but, if the heat is still continued, the gases and metals evaporate, combine at the surface with the adjoining oxygen, and form a porous oxyde. When the atoms combine with the solid, they become fixed, retain their atomic form, but lose their motion, and, in parting with it, confer on the bodies the sensation of heat.

OXONIAN.

But the term heat-making implies a quality.

COMMON SENSE.

No,—heat-making rays have not more heat, *per se*, than light-making rays. The heat is the result of motion transferred, and of vibrations in both kinds, but some give more heat, other things alike, because they are dense or large, while others afford more colour than heat.

OXONIAN.

It would be interesting to know how these moving atoms mix, or act relatively to each other.

COMMON SENSE.

How they mechanically mix, I do not affect to know. That they are driven into spherical orbits is certain, because, when evolved, they go into space previously full; and because this explains with precision their power of filling a larger space. On the subject of mixing, that ingenious philosopher, Mr. Dalton, has published some rational speculations, but as he did not consider the atoms as moving in orbits, his conjectures are irrelevant.

OXONIAN.

The union of atoms in definite proportions, seems difficult to reconcile with a mechanical theory.

COMMON SENSE.

I am aware of no theory which will so well explain it. You, probably, remember Kepler's curious proposition, in which he demonstrates, that we can have only sixteen fixed stars of the first magnitude, because only sixteen bodies could be placed in space equidistant. This ingenious idea applies to the mixture of atoms of various bulk, form, and energy. If we suppose a space partly filled with certain atoms, and that others can be admitted, in some relative quantity, or number, to the other, thereby filling up interstices; then, of course, this can be done only in certain definite proportions between the two. If the space is to be filled with atoms of different powers, and these powers are definite, their mixture must also be definite, and governed by their relative powers, or by the spaces which are left, or which they have to fill. Of course, the mixture, as to one, will be like Kepler's fixed stars, as to celestial space.

OXONIAN.

It would be disingenuous to deny, that I have been enlightened by this discussion. The smallness of organized bodies bespeak such activity in the smallest spaces as you confer on atoms, and, in many other respects, the causes and phenomena accord.

COMMON SENSE.

Compare these doctrines with the vague notions hitherto taught, or, rather, with the utter want of all previous analysis. Atoms, according to some, flying in all directions, in straight lines; and, according to all, possessed of properties *per se*, yet mingled in utter contempt of these properties—a chaos without order, system, or possible power of producing the harmony and beauty of the universe.

END OF DIALOGUE II.

DIALOGUE III.

Electricity, Galvanism, Magnetism, Cohesion, &c. &c.

OXONIAN.

I THINK you have established the facts that Gas consists of atoms in circular motions; and that Light and Heat are mere accidents of matter; hence we get rid of some imponderable elements, as they have very whimsically been called. I now wish to hear your opinions, as a materialist, about ELECTRICITY, GALVANISM, &c., the operations of which so little accord with the sluggishness of matter. I suspect you will find in these an imponderable element.

COMMON SENSE.

I will abandon the study of Nature if I find any imponderable elements. Nature is not so absurd as men would make it. Let us examine a galvanic combination. It consists of two surfaces of varied conducting powers of motion or heat; that is, of surfaces whose atoms are so peculiarly arranged as to generate peculiar local atmospheres, and permit assimilation with other atoms in a free gaseous or liquid state. Between these surfaces nitrous acid, combined with water, or hydrogen, nitrogen, and oxygen, are introduced. Well, then, we have two surfaces of different conducting power, and nitric-acid, or nitrogen and oxygen and water, or hydrogen and oxygen, in combination lying between them. The oxygenous atoms, are, as I have already noticed, those which most readily distribute or part with their motion, and these incline towards the best of the conductors, while the other atoms remain on the worst conductor, for the quantity of both continues the same. The result is shown by the state of the plates, which require to be frequently wiped, and the intermediate fluid renewed. If, then, the positive end, as it is called, be passed through a violet infusion, it converts it into red; while the other, or negative end, as it is called, passed through a red infusion, converts it into violet. The whole is merely a mechanical separation of the principles existing in the intervening fluid, and accumulated on or towards appropriate superficial conductors.

OXONIAN.

I comprehend the construction and separation. but how do you explain the resulting power?

COMMON SENSE.

By the simple fact that the contrasted powers of extended surfaces are mechanically restored through a point. The point, in consequence, exhibits the force of the entire surfaces in concentration.

OXONIAN.

As far as the test of colours affords proof, we have the acid and alkaline principles in separation.

COMMON SENSE.

Yes, we seem to have the oxygen at one surface, and the nitrogen and hydrogen at the other, and these are the constituents of ammonia. The different actions of copper and zinc on oxygen and hydrogen are the causes of the separation.

OXONIAN.

Well, but you have neglected the chief phenomena, their light and heat.

COMMON SENSE.

I thought it explained itself. Did you ever know of the rapid union of these gases without light and heat? A large volume is disturbed and in opposite states,—it is restored through a point,—and the reunion and concentration of the principles of oxygen and hydrogen, through a point, is a circumstance calculated to produce the effects of light and heat.

OXONIAN.

So then the light and heat of the galvanic fluid is, in truth, the mere accident of volumes of oxygen, and nitrogen or hydrogen, being separated, and then re-combined through a point?

COMMON SENSE.

Nothing more: what more should it be? Did you not put the very things there? Was it not the effect of the combination to develope them? After you had separated them, did you not, as your own act, place two connecting points so near as that the most prominent parts received the double rush? And then would not such re-union be attended with the usual results of heat and light? These were your own acts, yet you talk of an imponderable element, of a fluid *sui generis*, and make a mystery of the plainest experiment in the whole circle of philosophy.

OXONIAN.

There never has existed a greater mystery. But why should they re-unite?

COMMON SENSE.

Union is their natural or undisturbed condition, and they unite and re-unite from some fitness in their mutual motions, which enables both gases to fill, maintain, and move in a certain space. Their disturbance or separation has arisen from some force, or difference between the motions of the respective atoms, and the exciting surfaces, by which the volume is bounded. There must be something intermediate to disturb, and separated bounding surfaces to create or concentrate the disturbance. But, as the disturbance arises from the separation and opposition of the surfaces, if these are brought together, or if continued from one to the other by a wire or rod, and so, in effect, brought together, then there exist no longer *opposed* surfaces, and, consequently, no disturbance; for without opposed separated surfaces nothing can be said to lie between them.

OXONIAN.

But in Electrical experiments we introduce no nitric acid. This fluid, therefore, cannot be so easily accounted for.

COMMON SENSE.

Quite as easy. The atmospheric air, composed of nitrogen and oxygen, lies between your electrified surfaces; and for the same reasons the very same results are produced; only that a nitric acid solution is stronger in the principles than atmospheric air.

OXONIAN.

So then a cloud contains no electrical fluid!

COMMON SENSE.

None. The air between the cloud and the earth is affected like your galvanic solution, and the clouds are one plate, and the earth another. The restoration of such large surfaces through some point, causes the thunder and lightning. These phenomena do not take place when the earth and the plate of clouds have the same conducting power. It is a natural galvanic series.

OXONIAN.

But how do you explain the excitement of electricity by rubbing, as in the ordinary machine? I cannot give up my old favourite, the electrical fluid.

COMMON SENSE.

In electricity, the excitement arises from the same general cause as in galvanism, that is, from varied powers of conducting motion applied to atoms differently susceptible of those powers. In galvanism, this varied power exists in the metals; but in electricity it is created by artificial motion applied to different surfaces, by which each surface, though subject to the same motion, is differently affected, and thereby differently affects the same atoms. Thus, the oxygenous atoms assemble on the surface most affected, and the others are left, as it were, on the surface least affected. Without understanding the cause, electricians have, by experiment, established this economy of electrical excitement. They rub two different electrics together, and as one has not the same atomic structure as the other, so they confer on them two degrees of motion, and thereby produce two varied effects on the atoms quiescent in their substance. In general, also, they adopt as the excitor some elastic body, as flannel, silk, hair, &c., the gases contained in which are more readily affected by the action and re-action of the parts. Nothing is created, there is no fluid *sui generis* and *per se*, no two fluids with atoms repelling and attracting—these are airy dreams—on the contrary, it is a mere mechanical separation of atoms, every where existing in natural combination, and in that state undistinguished by special phenomena, while in their separated state, and in their re-combination they exhibit certain striking phenomena.

OXONIAN.

As in an electrical machine, my rubber is elastic, and the glass decomposes the gas within it, becoming itself positive, would not the rubber soon part with its oxygen ?

COMMON SENSE.

It would, but for a new supply. The rubber becomes in a contrary state from the glass, or negative, and thereby affects a plate of air around it, which, at a certain distance, becomes positive, and renders all bodies at that distance in the same positive state. This plate of air is then restored by a continuous surface, as a chain or wire, from the rubber to the ground, and hence, as the rubber is exhausted of its oxygen, it is simultaneously restored again, and kept in its original condition.

OXONIAN.

In fact, there are similar processes taking place on each side the glass cylinder, but the provisions of the electricians are different. What is the operation of your points?

COMMON SENSE.

The excited glass cylinder also affects a plate of air all round, perhaps, as far as the extremity of an ordinary conductor, which stands like a connecting rod, between the surface of the glass and the negative surface, produced by its distant influence. The points then receive it as a means of restoring the plate of air, but the conductor being insulated, it affects a new plate of air all round, the restoration of which plate of air creates all the phenomena of the conductor.

OXONIAN.

Hence, I perceive that the object of connecting the rubber with the ground, is not to draw electrical fluid from the earth, as is universally asserted, but to restore an affected plate of air.

COMMON SENSE.

Conceit most whimsical! The rubber having lost its oxygen, becomes the negative side of a plate of air, the boundary of which is the ground, and other distant bodies; hence, by uniting the surface of the ground with the rubber, I restore the disturbed plate as fast as it is created, and keep the rubber in its original condition.

OXONIAN.

Then I don't extract the electrical fluid from the rubber?

COMMON SENSE.

There is no more electrical fluid in the rubber than there is pain in a stick, it is the effect of gaseous disturbance and restoration. The air or gas within the elastic substance is compressed and mechanically decomposed; then the oxygenous or acidulous part attaches itself to the non-conducting glass, and affects the adjacent strata of air and glass, which, of certain definite thickness, exhibits, at its opposite side, the contrary, or alkaline qualities. Small points, successively presented to the surface of the glass, receive the same condition, and extend it to the conductor, which in like manner disturbs a stratum of air all around it. The restoration of two large surfaces, or of the contained stratum, through a point, exhibits light and heat in the re-union of the acidulous and alkaline principles contained in the air. There is no mystery but in the mechanical mode in which the invisible gases are separated and reunited; but it is plain there is no fluid *sui generis.*

OXONIAN.

I am astonished—am I to understand, then, that bodies do not contain electrical fluid, some more than their natural share, and some less? Your scepticism on every subject provokes me. Have all the philosophers of Europe been labouring for two hundred years to find nothing but errors?

COMMON SENSE.

I utterly deny that any electric fluid ever enters any body, and that there exists such thing as an electrical fluid. The oxygenous and gaseous principles within a substance may be disturbed, as within glass for instance; but no power of that kind ever was found *within* a conductor. Glass, wax, &c. &c. are non-conductors merely owing to their own susceptibility of electrical action; but a conductor is as powerful, whether it consist of paper covered with gold-leaf, or of solid gold. The effects are in the air lying between any surfaces of different matter, which bound the electric volume. Electricity is nothing more than a mechanical separation of the constituents of the electrics, and the chief phenomena are occasioned by the circumstance of restoring extended surfaces through points.

OXONIAN.

On your theory, how do you discriminate between conductors and non-conductors, or non-electrics and electrics, and in what lies the difference of their operation?

COMMON SENSE.

In replying to this question, I fear I shall be found as heretical as on other points. If there is no electrical fluid, there are, in the usual sense, no conductors. If no fluid enters a body, the distinction of conductors and non-conductors does not exist. At the same time, there are bodies capable of being excited, called electrics, and bodies incapable of excitement, called non-electrics, or mere surfaces, or boundaries of the disturbed strata.

OXONIAN.

No conductors! Have I every thing to unlearn?

COMMON SENSE.

Bodies are called conductors, because the fluid is said to pass freely through them,—but there is no fluid,—hence, nothing to pass. It is wonderful how so absurd a notion could be maintained, because, it is notorious, that a pasteboard conductor, covered with gold leaf, exhibits as powerful an electrical action as a conductor of solid gold. In truth, perfect conductors are such, because they have no actual concern with electrical action, but only incidentally, as bounding surfaces and defining action.

OXONIAN.

How, then, do you discriminate between conductors and non-conductors?

COMMON SENSE.

The best perfect non-conductors, as air or glass, are such, because they create, and determine the electrical action, which begins and ends in them. A plate of air is a non-conductor; solely because it is itself the local patient of electrical action. It is a non-conductor, because the excitement is created within itself, and *locally* exhausted. But a *plate* of air must, as such, have a boundary; and if meant to exhibit complete excitement, must have for its boundary a surface unsusceptible of excitement, as gold-leaf or tin-foil. If the boundary were glass, the glass would divide the excitement; it would renew it on the opposite side, and affect another plate of air. But, if we bound the plate of air by a *neutral* surface, and such are non-electrics, then we get an excited plate of a definite size, measured at its base by the neutral surface, on or near which is accumulated one constituent of air, or one term of electrical action; while the other, with or without a boundary, is accumulated above or opposite.

OXONIAN.

If conductors are not conductors, how do they conduct the excitement, as we know they do, by our constant experience?

COMMON SENSE.

The two principles of the electric seek to reunite in their natural state, but being unable to unite in the perpendicular direction, exert their force horizontally, or at right angles to each other; consequently, if I increase the size of one boundary, by adding more gold-leaf or tin-foil, the action will expand itself by the simultaneous energy of both the affected sides of the plate of air, for the extent or breadth of the disturbed air, is determined by the extent of the next neutral boundary. This force of lateral diffusion is mistaken for the conducting power of the metallic or neutral surface. The affection of the plate of air, or glass, is therefore, extended, as I extend the neutral boundary or size of the surface. Restoration is sought laterally, and each side spreads, therefore, as the other is enlarged.

OXONIAN.

Explain more fully why the energy seeks to diffuse itself laterally.

COMMON SENSE.

Because, as the suitable condition of the atoms is deranged, in the disturbed state, and certain conditions of their motions are unsatisfied, and as, by the hypothesis, the restoration cannot take place directly or perpendicularly, so an assimilation of the powers of each surface is sought in the adjacent spaces. On each surface, a state of motion greater or less exists than in the spaces adjoining, and, therefore, a diffusion takes place, if greater, from that surface to the adjacent atoms; and, if less, from the adjacent atoms to those of the surface. The laws and force of fit and suitable gaseous mixture are, doubtless, also concerned.

OXONIAN.

How do you explain the radiation of electrical action, or the power of one side of a plate of air, to affect its distant parts?

COMMON SENSE.

Of course all radiation; other things alike, must be as the square of the distance; but as the gases concerned move freely through perfect electrics, imperfectly through others, and not at all through conductors (as they are mis-called), so the dispersion of electrical action depends not on the excitement, but on the bodies within the adjoining space, and hence its apparently capricious character.

OXONIAN.

What is the use and effect of coating a plate of glass, or air?

COMMON SENSE.

Glass and air are electrics; i. e. an excitement, produced upon or in them, affects their constituent principles, by assembling, as its result, one principle on one surface or side, and leaving the other principle on the other opposite side. But a plate of glass or air is not a plate, without it has terminating surfaces; which surfaces, to define the affections of the plate, must consist of a material which does not partake of, or divide the excitement, such as the metals and bodies, improperly called conductors. The size of the plate, too, is as that of the said surfaces, and the extent of the excitement in an electric plate, depends on the smallness or largeness of the surfaces, called coatings when applied to glass, but equally so when applied to air, or any other electric. Without such definite unaffected surface, the excitement would exhaust itself in the electrics, and be dissipated by fining off into distance, or by alternating in diverging strata.

OXONIAN.

And is it in this manner that the excitement proceeds along wires and rods: are not the wires and rods imbued with the principle?

COMMON SENSE.

Certainly not. It is the propagation of an affected plate of air; and when we bring two contrarily electrified knobs or surfaces together, the two atmospheres are then reunited with energy. Galvanism, from this cause, unites aerial with its own peculiar action, because, when the affection is conveyed along the wires to the poles, the propagation is then made by acting on the air as in electricity.

OXONIAN.

But the propagation is instantaneous.

COMMON SENSE.

This proves that it is no progressive fluid. The aerial effect travels as fast as it finds surface. There is nothing to stop it. It is like the propulsion of a bar of wood. It goes with the surface, as rapidly as it finds surface. The two affected sides are as a body and its shadow. Infinite varieties exist, however, in the phenomena, from the diversity of electrics and neutrals, and from bodies being partly one and partly the other.

OXONIAN.

How do you explain the phenomena of restoration?

COMMON SENSE.

It may be perfect or imperfect; i. e. the gaseous principles may be reunited directly or indirectly. All excitement is made in a sphere, the centre of which, in electricity, is the glass exciter. The rubber makes an hemisphere from negative to positive, and the prime conductor another hemisphere from positive to negative. The action commences from the centre, and the centre may be directly restored, thereby restoring the spheres; or the hemispheres may be connected, by joining the two centres with the ground, as part of the affected hemispheres. The first is direct restoration, the second indirect. In cases of indirect restoration they will be dispersed in the opposite hemispheres; but in direct restoration the action is mechanical, for the disturbed chemical elements will directly re-combine; hence their passage even through acids and alkalis. If they affect bodies chemically, it is when either is discharged locally, and it will then combine with any opposite element, into which it is discharged. The rapid re-union produces, mechanically, the heat, light, odour, dispersion, &c., and all the effects of the highest concentration of atomic motion.

OXONIAN.

But if electricity consists of a species of stratum, of one of the gaseous principles, how happens it that its presence is not sensible, as in the case of an affection of the earth's surface ?

COMMON SENSE.

The presence of such stratum is so palpable, that it alone confirms the new theory. Consider it in the divergence of pith balls, and in the well-known affection of the human constitution, previously to a storm of lightning. The dry earth becomes a non-conductor, and the air is excited, oxygenously in the upper regions, and contrarywise below. The effect extends to an indefinite distance; but passing clouds confer a definite and condensed character on the plate, by serving as a coating to it, when morbid animal action, diminished animal energies, and increased divergence of pith balls, are the consequence. The storm restores the equilibrium, and the attendant rain, by rendering the earth neutral, destroys the cause; when relief and change are universally experienced. In truth, the plate of air between the surface of the earth and cloud is the only thing affected; the cloud is merely one coating, and the earth another. Sometimes the lower tier of clouds is affected; these affect upper tiers, and vary the phenomena. The lightning arises from the restoration of large surfaces, taking place through points, when the re-union by a double rush causes the light, heat, and force.

OXONIAN.

But after all you have not accounted for the attractions and repulsions of electricity,—for those laws on which so curious a theory has been raised, of fluids whose atoms repel in the same fluid, and attract in each other.

COMMON SENSE.

I thought I had exhibited the absurdity of the very idea of attraction and repulsion, in genus and species. When such appearances take place, their cause must be mechanically explained.

OXONIAN.

I do not insist on attraction and repulsion, after what has passed, but I am curious to hear your explication on this subject.

COMMON SENSE.

It will be brief, but clear and conclusive. When a plate of air is in an electrical state, it is so (as has been explained,) because its two surfaces are in opposite chemical states, acid and alkaline.* The air within the plate is in a state of disturbance, consequent on forces transferred, and seeks its usual condition of regular commixture by re-action. The force with which the two surfaces seek to re-unite is indicated by the intensity of the spark which restores them through a point, and it is such that the surfaces themselves endeavour to collapse.

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* The terms acid and alkali have been preferred, as established and general, but the author is perfectly aware of the qualifications often necessary; and he agrees in the opinion that azote is a gaseous compound, but this is of no consequence to his general principles.

OXONIAN.

So far is plain.

COMMON SENSE.

Well, then, if within the affected plate of air, is placed any light body, whose inertia is less than the force exerted between the two surfaces, that force will drive it from surface to surface, as a means of restoring the equilibrium of the two surfaces. There is no plus or minus, or *per se* power, of repulsion and attraction, but the simple energy of the acid and alkali, to re-combine in the plate of air. Nor is it necessary that the plate of air should be regularly formed, for one regular surface is sufficient, and the other surface may be formed by the body or hand of the operator, or by the walls of the room.

OXONIAN.

But how does your theory of electrical matter accord with the decomposition of the alkalis?

COMMON SENSE.

It is neutral as to fact, but at war with the reasoning on which the result is explained. Oxygen and hydrogen are not attracted to the poles; their principles constitude the very poles. It is the energy of their union, the intensity of their atomic action, which separates and gassifies the oxygen, combined with the potassium. The result has nothing to do with the pole in a chemical sense, but only in a mechanical one. The separation requires an extraordinary and concentrated atomic action, for atoms act best on atoms, and such action is created between the poles by the re-union of large excited surfaces through a point. If the emission of force from the pole were chemically or electrically to act on the potassium, there would be a discharge, but no action between the poles.

OXONIAN.

How, then, do you reconcile the galvanic and French methods of making the alkaline metals?

COMMON SENSE.

All alkalis exist, necessarily, in connexion with some oxygen, owing to their strong mutual action and re-action; and the separation by the mechanical action of galvanic restoration, or of the motion, called heat, in the gun-barrel, presents to us the alkali, unadulterated by oxygen, in the metallic substance called potassium.

OXONIAN.

Whence proceed the great operative powers called acidity and alkalinity?

COMMON SENSE.

They are consequences of the generic forms of atoms, of their varied susceptibility of excitement, and of the ratio of the motions by which each exerts power in the same space. When in combined motion, they neutralize each other's peculiar action, produce a joint result, making or destroying the single effect of each, on other atoms, and on the animal senses. The great and universal forms in which they exist in states of neutralization, are the atmospheric Air, in which one quantity of oxygen is neutralized by three and a half of nitrogen; and in Water, in which eight quantities of oxygen are neutralized by one of hydrogen. Oxygen is the acidifying power, and is, as we know, not only neutralized as described, but its two neutralizers form the volatile alkali, or ammonia. Air and Water, then, are the great natural store-houses of these operative principles, and the capability which most substances have of combining with them separately, and in various proportions, as well as their own antagonist or correlative powers, create all the infinite permutations of substantial phenomena.

OXONIAN.

Are nitrogen, chlorine, &c. compounds?

COMMON SENSE.

As it appears that much larger quantities of Nitrogen are required than Hydrogen to neutralize the same oxygen, there may be some superfluity in nitrogen, and then assuming hydrogen as the standard of neutralization, or the prime alkali nitrogen must consist of hydrogen and some base. At the same time, as air and water are necessary fluids, Nitrogen may be as original a terrestrial element as Hydrogen, though its contrast to oxygen may not be so efficient. I dislike the nitricum and oxygen of Berzelius, nor do I more approve of his electric energies as powers *per se.*

OXONIAN.

Do you consider Chlorine, Iodine, &c. as compounds; or the combustible character of sulphur and phosphorus, as arising from Hydrogen?

COMMON SENSE.

Like other chemists, you are confounding mere powers and effects with supposed qualities! Gaseous elements are simply matter in motion. Permutations in the effects arise from different ratios of power, and from accidental combinations. If effects on the same thing are similar, the causes are similar, call them what you will. If chlorine, or any other gas, is fixed by the evolution of hydrogen by motion; and if flame and combustion take place, then Chlorine is but another name for the very same power as that of oxygen. In like manner, if heat produce an evolution of gas from phosphorus, which by correlative motion fixes oxygen, then the phosphoric evolution which creates phosphoric acid, is but another name for the very same power as hydrogen. So, likewise, if potassium burns in sulphuretted hydrogen, it proves that the latter has equal power with Oxygen, and in that relation is but its synonime; and again, if metals burn with sulphur, it appears that the ratio of the power is similar to those of the gaseous powers called oxygen and hydrogen. The general test is relative power, or ratio of power, and sound nomenclature should indicate atomic power, and its ratios, not absolute principles.

OXONIAN.

What do you mean by correlative power?

COMMON SENSE.

I mean equal power of different matter distributed through the same space, resulting from velocity varying inversely as matter. *Free, undisturbed* *space, is occupied with plenitude of power; not, as has been supposed, with plenitude of matter.* One cubic inch, other things alike, contains as much power as another. If there is less matter, there is more motion, and if more matter, less motion; the quantum of power being always equal within the same space. But, whenever disturbance takes place by any excitement, on one side of a given space, then motion preponderates on that excited side, and the matter is driven to the other side. This is correlative power, and phenomena are the consequences. So, again, if the excitement on one side is abstracted, then matter preponderates on that side, motion on the other, and phenomena result. The atoms, likewise, are not similar, and hence permutations in the phenomena. Boundaries of the space, consisting of different matter from the matter affected within the space, are, of course, pre-supposed, and the varied re-actions of these also diversify the phenomena. These principles, honestly applied, will solve most, if not all, our electro-chemical phenomena.

OXONIAN.

The chemists consider acid and alkaline powers as correlative, and mutually dependent.

COMMON SENSE.

And so they are, when free, and in their gaseous state; and hence all the phenomena of Combustion, Electricity, Galvanism, and Magnetism.

OXONIAN.

MAGNETISM has hitherto been the stumbling block of philosophy. Its connexion with electrical, and, therefore, with galvanic action, has been recorded for a century. The obscurity in which it is involved, seems to have arisen from implicit faith in the electrical fluid, and the impossibility of connecting the phenomena with the properties of that supposed fluid. Hence, galvanic and magnetic fluids have also been imagined. Your clear exposition of the nature of electrical and galvanic action, leads me, however, to hope that you will throw some new light on magnetic action.

Common Sense.

I consider magnetic action to be exactly analogous to that of electricity and galvanism, though its origin is different, its agent different, and, therefore, the bodies, which are its patients, are not the same. Its origin is natural. It is a natural galvanic combination; but, instead of atoms separated in the trough, they are separated on the surface of the magnet. It has also a species of electrical action on the space around, the re-actions of which produce what are called attractions and repulsions. Nor does its action appear to separate the same gases as electricity and galvanism, for the re-union through a point does not produce light and heat, and the energy is perfect under a receiver exhausted of electrical principles. Moreover, its influence is more subtle than electricity, which permeates and affects only a small range of electrics, and has an extensive range of non-affected bodies, or non-electrics; whereas, all bodies in nature are magnetic, and susceptible of receiving and transmitting magnetic action, and the only non-magnetics are loadstone, iron, and nickel.

OXONIAN.

Hold—I find it difficult to follow you through so many novel positions. What, then, you consider a magnet, or magnetized body, as having a local atmosphere in perpetual natural excitement, or atomic separation from one of its poles to the other; and that the poles produce a sphere of separation like a plate of air, bodies in which sphere are in a contrary state, and, therefore, re-acted upon, and attracted; and hence the repulsion of the same poles, and the attraction of contrary poles. First of all, tell me what you mean by a local atmosphere?

COMMON SENSE.

Local atmospheres are well known to all experimentalists, and in all atomic phenomena are of primary importance. They are created on the surface, and in the superficial parts of all bodies, by their re-actions on the active elastic media in which they are situated. According to their peculiar structure, they condense or decompose those atoms in different ways and proportions, and these combine with the exhalations, or evolved gases. It is the varied re-action of these atmospheres, which confers on bodies varied degrees of sensible or specific heat. In fine, these local atmospheres, as generated by different bodies, prevent or facilitate the perfect union of their parts, and keep at a perceptible distance their actual surfaces; while their varied constituent parts, and consequent re-actions, create all the calorific, colorific, electrical, galvanic, and magnetic phenomena of bodies.

OXONIAN.

It seems to be in magnetism as in electricity, that the power depends on the surface, for any thin plates of steel, or magnetic ore, are as efficacious as solid magnets; consequently, it must be an action of the surface; and, as it affects bodies at a distance, must be an action and re-action on the adjoining space; but I am confounded by your nomenclature, which calls all bodies magnetics, and iron, &c. non-magnetics.

COMMON SENSE.

This cannot be wrong. Do not all bodies permit the free passage of the influence. Are not iron, &c. the only obstructors of its influence, and, therefore, the only patients of its action and re-action. When we apply a test in chemistry, we do not employ the body to be tested, but some body of antagonist character. Iron, &c. are the tests of magnetic influence, and, as tests, are not themselves magnetic. If they were not tests, they would readily transmit its influence. They are like conductors, or non-electrics, in electricity; they are surfaces, on which to display the energy of a magnetic plate, and not themselves the originators of the power. They are either passive, or antagonist to the power.

OXONIAN.

So, then, you think the atmospheres of magnetic bodies are in a state of gradual permanent separation from pole to pole, and are tests of some principles in the atmosphere, partly, if not wholly, different from the principles which cause electrical action; and that the mechanical affections on the bar are like those of a galvanic trough, and those around the poles like those of an electrified plate of air, also as in galvanism.

COMMON SENSE.

If we call the north pole positive, it acts all round like electricity, on certain principles in the adjoining space, and also along the length of its own atmosphere. Iron, &c. is its neutralizing surface, and, placed opposite to a magnet, forms a plate of disturbed space, just as a non-electric forms a plate of air in electricity. The two sides of the plate formed by the pole, and the iron having been separated by force, seek to re-unite with equal force, and hence the iron is carried towards the magnet. The positive pole affects the whole length of the magnet progressively; and hence the other end is negative, and any piece of iron opposed to that pole, would become positive, and they also would unite on the same principle. The modes of action are the same as in electricity, except that I imagine the principles acted upon are different, and hence the number of neutral or permeated bodies.

OXONIAN.

How do you explain the transfers of magnetic power; and the multiplication of poles, by galvanic action?

COMMON SENSE.

The first, by the transfer of the atmospheres, or parts of them; and the second, by the neutralization or destruction of the atmospheres at the points of contact. A white heat, as might be expected, dissipates the atmosphere, and various actions on iron create an atmosphere, and render the iron magnetic, while other affections of the surface destroy its influence.

OXONIAN.

But how do you account for the polarity, variation, and dip of magnetic needles?

COMMON SENSE.

You mean special direction, in particular places. Of course, it arises from a connexion between some external circulation, or direction of motion, and some action and re-action between the matter in circulation, and the affections of the excited atmosphere of the magnet; while the phenomena require that it should be of a kind indifferent to the re-actions of all bodies, except magnetic ones. The dip and the local variation seem to point to the mass of the earth as the operative cause. I see no difficulty in conceiving, that the constant pressure of the heterogenous materials of the earth towards the censcarcely believe the existence of the air in which they live, because, in like manner, they do not see it. In regard to the emission of streams of rare atoms from the earth, arising from the actions and re-actions of so heterogenous a mass, consequent on the two-fold motion, and the constant pressure of the whole, nothing can be more probable, while it constitutes an efficient agent, and exactly solves the phenomena. You may, however, not be right in your causes of its varied direction; for in so compound a system, in which the strata exhibit such varied re-actions, from the equator to the poles, more than one force may be concerned in giving direction to the mundane effluvia. Its abundance, and great directive force at the poles, seems to be a necessary consequence of the same excess of pressure which produces the flattening of the sphere. The circumstance, that the plane of the orbit does not accord with the plane of the equator, and the inequalities which must result from the composition of these oblique forces, particularly as applied to so irregular a structure as the earth and waters, whose parts are so contrasted and opposed, and yet so diversified and irregular, render it difficult to submit these compound actions and re-actions to rigid analysis; yet they present data on which to found a solution of the cycles, and the peculiar mundane curves of magnetic variation.

Common Sense.

I thank you for these observations, and am forced to agree with them. If I am not quite correct, I am quite sure I have made an approximation; and if some of the machinery are still left in obscurity, the nature of the phenomena does not permit of ocular proof. My theory will, however, I hope, bear a comparison with the incongruous jargon of M. Æpinus, about his attractions and repulsions of iron, and of the fluid; and with the gratuitous assumptions of Halley and Churchman, about their great internal magnets, their revolutions, and I know not what absurdities. My object in entering the lists has been to shew, that these phenomena present no objection to my great principle of universal causation, *matter in motion;* and that even magnetism is susceptible of more rational explication in accordance with this principle, than with the puerile doctrines about innate attractions and repulsions, fluids *sui generis*, &c. &c.

OXONIAN.

Attraction is a palpable absurdity, yet I am at a loss on any other principle to account for the attractions of floating bodies, of CAPILLARY TUBES, of glass plates, of mountains, &c. Gas may transmit or diffuse forces, but what has it to do with these isolated phenomena? Attraction may be a demonstrated absurdity, yet in using the term I do but describe the phenomena, and assign no cause.

COMMON SENSE.

The very term includes a cause: if several boats congregate round a ship, or several small corks assemble round a bung, you assume a knowledge of the cause; for in the term attraction you infer some innate power in the ship or bung, like the centripetal force ascribed to the planets in regard to the sun; and then in ascribing such centripetal, or attractive central force to bodies, you involve yourself in a labyrinth of false analogies, and erroneous reasonings: as the ascribing of attraction to mountains, founding calculations upon it, &c. &c. while La Place has filled a volume with calculations about capillary attraction, and the chemists follow in the train with their miraculous and conjuring affinities!

OXONIAN.

If sufficient and satisfactory causes can be assigned, they ought to be severally understood and adopted.

COMMON SENSE.

Well then I shall make no delay in describing the causes. The whole of these phenomena arise from the pressure or elasticity of the gas of the atmosphere. They are so many variations of the principle of the barometer, and arise from partial interruptions of that pressure, which we know is equal to 15 lbs. to the square inch; but in the construction of the barometer the interception is rendered complete.

OXONIAN.

I understand the principle, but do not see its application.

COMMON SENSE.

Suppose a bung is placed in the middle of a large surface of water, it is evident the bung is pressed all round by the elastic atmosphere; i. e. a pressure, so to speak, flows in towards the bung, from every side, equal to 15lb. to every square inch on the superficies of the bung.

OXONIAN.

Of this there can be no doubt.

COMMON SENSE.

If, then, I place a cork on the same water, at 3 or 4 inches from the bung, it is now evident that the general pressure is mutually intercepted on the near sides of each—that the bung intercepts a large angle from the cork, and the cork a small angle from the bung, on their near sides—while on their remote sides, the pressure is general and complete.

OXONIAN.

Demonstration!—I understand it perfectly. The difference is the quantity of force which drives them together. It is as their mutual angles. The cork intercepts the smallest angle, and the bung moves slowest, while the bung intercepts the largest angle, and the cork moves the fastest. The angles increase as they approach, and hence their velocity increases till they come into contact. The solution is complete; yet the phenomena equally agree with the powers ascribed to attraction, and how can you shew that it is not attraction?

COMMON SENSE.

Nothing is more easy: I shall shew that the phenomena depend on the air. If it were attraction the approach would be quicker and more decided, when the bungs have double or treble the density of matter contained in the cork.

OXONIAN.

Doubtless, double the quantity of matter would be attracted with double the force.

COMMON SENSE.

Make your bungs, then, of oak instead of cork,—place them in water, and their upper surfaces will float level with the water; but place them ever so near, and they will never approach. They are mere logs in the water. Not exposed to the pressure of the air,—they create no interruption, and exhibit no phenomena. If you load the cork bungs, so as to immerse the same bulks in the water as the oak bungs, they will always approach while above the water, and intercepting the aerial pressure; and generally the approach will be more or less rapid, as more or less of the cork rises into the air; and in bodies of different density, the approach is as the quantity of matter, because the inertia to be overcome by the common force of the aerial pressure is as the density.

OXONIAN.

So then a mountain intercepts the pressure on a plummit on the same principle; and just so Cavendish deceived himself with his poised lead balls! Then neither the one nor the other of these vaunted experiments had any concern with terrestrial attraction. But do not dry bungs exhibit particular phenomena?

COMMON SENSE.

None that apply to my explication more than to the doctrine of attraction. The corks and the fluid have their own atmospheres, and these atmospheres occupy a space round them, till they assimilate. Owing to the re-actions of the atmospheres, the cork makes a bed on the surface, and raises a convexity around, which counteracts the atmospheric pressure on my theory, or the attraction, on your's. It is a mere mechanical variation: the same takes place in quicksilver and from the same cause.

OXONIAN.

But in the attraction of glass plates on fluids, there is but one body and nothing to intercept.

COMMON SENSE.

Are there not two sides? Does not the plate intercept the atmospheric pressure from each other-side? And at the line of contact, is not the entire pressure from one side taken off, while it is complete on its own side? One half of the atmosphere presses each side of the water, and the last atoms nearest the place of contact receive no pressure in the opposite direction, and therefore rise up the plate. And when two parallel plates are nearly in contact, then the fluid outside of the plates is pressed with the whole weight of the atmosphere; but almost the entire pressure on the fluid between the plates, is intercepted by the plates, and of course the fluid rises between the plates. And as the interception is greater in the centre of the plates than at the quadrants of the open sides, so the fluid rises highest in the central parts, and the law of action and re-action generates a curve.

OXONIAN.

But do not the actions of capillary tubes, about which so much mathematical learning has been employed, present great difficulties ?

COMMON SENSE.

No difficulties whatever, for the very same reasoning applies to all capillary tubes. The atmosphere presses the fluid within the tube only down the tube; whereas the whole weight of the atmosphere is exerted on the surface without the tube, and the fluid rises, owing to the difference of pressure. The decreased pressure within the tube is as the angle which its top makes at the surface; hence fluids rise higher in long tubes than short ones, and in those of small bore than large ones. The whole is a mere mechanical affection, and has no connexion whatever with the essentially absurd principle of attraction,

OXONIAN.

The advocates of attraction lay much stress on the attraction of COHESION.

COMMON SENSE.

I care not what name they confer on any particular attraction; as attraction it is necessarily an absurdity. An attraction of cohesion might be maintained if bodies were not situated within an elastic medium, pressing at 15lbs. to the square inch, if atoms were not of fitting and unfitting forms, and if all bodies had not their own local atmospheres. Pressure, form, and local atmospheres, will explain all the phenomena of going together, of affinity, and mutual action; while unfit atomic forms, and unassimilating local atmospheres, will explain apparent repulsions and want of cohesion. I am aware of no difficulties, and if any were invented, it would be more rational to endeavour to remove them, than to maintain the existence of absurd principles of attraction and repulsion.

OXONIAN.

I perfectly agree with you, and it is impossible to disagree, unless I were to shut my mind against the light of reason. Even some irregularities and peculiarities which present themselves to my recollection, do not seem to afford valid objections, and may, I should think, be easily rendered conformable to your new theory.

END OF DIALOGUE III.

DIALOGUE IV.

Miscellaneous and Explanatory.

OXONIAN.

I NOW understand with precision, all the obscurities of electrical action, and the causes of all the varieties of attraction: yet I have many questions to ask, relative to points connected with the subjects which we have already discussed, and others growing out of my old and new views of nature.

COMMON SENSE.

I can never be wearied in giving explanations to so liberal an auditor. I lament, however, that my meaning is often obscure, from my desire to say the most, in the fewest words; while, as your questions frequently involve points already discussed, I am forced to make repetitions, in the hope of rendering my positions clear. If you are not tired of questioning, I shall continue to answer with cheerfulness.

OXONIAN.

I am satisfied, from your various elucidations, that the aggregations of planetary bodies arise from their two-fold motions, yet I have difficulties about the fall of a projectile. Would it not, when it has attained its elevation, revolve with the earth in the situation it might have attained, and would it ever return without being attracted?

COMMON SENSE.

I am much astonished at the question, because it is answered by every principle which I have developed on the subject. Remember that the earth is revolved by one force, common to all the bodies which compose it; that the same force carries bodies through distances inversely as their densities, and, therefore, that the proper force which revolves the earth is only competent to carry bodies in circuits, or in radii, inversely as the densities. That is to say, the common force is incompetent to carry a mass of lead, through the same distance or circuit of the diurnal rotation, as an equal bulk of air. The mass, or centre of the earth, and the mass of lead, must approach; for the centre of gyration must be the centre of the quantity of matter in the whole earth; and as that totality will not move towards a small mass of lead, the lead gives way, and falls, or endeavours to fall, towards the centre, or to a circle of rotation nearer the centre, in the length of which circle the common force is competent to carry it round in twenty-four hours. Hence, at the surface, the common force is competent to carry gas a little rarer than atmospheric air, without centripetal force. If, then, at the surface, I raise a ball of lead with my hand, by re-acting with my muscular lever against the ground, I merely overcome its previous tendency to fall nearer the centre. If, by a further exertion, I project it perpendicularly into the air, the new direction of motion, arising from the force imparted, continues till the new force is transferred to the air, and the ball then becomes again the patient of the very force which urged it towards the centre before I raised it from the ground; and, being unsupported, that force brings it again to the ground, and there it is arrested by the structure of the mass; the continuous force accelerating its fall, and all the adventitious force being transferred to the earth, it retains only its original tendency to fall lower, if it could.

OXONIAN.

Nothing can be clearer,—and nothing could be more absurd than the notion, that it would remain suspended, if not attracted. I forgot that it possessed a previous impulse towards the centre, and that, although raised by a new deflecting force, it had not thereby parted with that previous impulse, or tendency to fall towards its fit circle of rotation. It should not, however, be forgotten, that you ascribe these natural inflections to the simultaneous orbicular force; and that without this greater force, they ought to be deflected in tangents, while Newton lays it down as a law, that any number of bodies, moving in the same direction, are not by such common motion, relatively affected.

COMMON SENSE.

This law would hold in regard only to bodies moving in a vacuum, to bodies of the same density moving in a medium, or to patients of any comprehending motion, like those within the cabin of a ship; but it would not hold with regard to bodies having different densities, moving in a medium, nor with bodies mechanically combined, and moved by a force which operated on the whole by a centre of percussion. If moved in a medium, and of various densities, those of least density would soonest part with their motion, and form a train to the most dense; and if operated upon as a system, the re-actions of the whole would create a centre of percussion, of which all would be the patients. You have to choose, therefore, between a vacuum in space, and a power of attraction operating through that vacuum, an absurdity and a compound absurdity; or a gaseous medium filling space, which explains all the phenomena on principles of transferred motion.

OXONIAN.

As the earth is in great motion while a projectile is ascending and descending, what is the line described by a body projected perpendicularly?

COMMON SENSE.

With reference to absolute space, a very obtuse curve; but the earth moving with it, the curve is not sensible to the projector, who, in space, is forming a nearly similar curve. Both would be operated upon by the same causes, and the only phenomenon is what takes place in the projectile, owing to its having been deflected; but the deflective force being imparted to the atoms of air, the projectile returns by the very centripetal force which it possessed before it was deflected; because the mass of the earth will not yield to the ball, and change its own centre of gyration. One of the two must yield to the rotative force, and it is scarcely necessary to state, that the yielding body must be the small ball. It would be slaying the slain, to say more on this plain subject. Dispute it who dare; refute it who can.

OXONIAN.

I think the doctrine indisputable; but you must expect to encounter cavillers, and it will be a hundred years before Newtonian Gravitation is expelled from the Universities of Europe. Some modern writers evade the dilemma in which their doctrines involve them, and justify attraction by quoting our ignorance of matter and motion, alleging, that we never come even into contact with matter.

COMMON SENSE.

Just so: the conceitedly ignorant rail at all knowledge, because we may never comprehend every thing. You cannot be ambitious to belong to this sect. We know enough of motion in knowing, that when a body changes its place, it then exhibits momenta and powers, in regard to other bodies; and enough of matter in knowing, that when so moved, it then possesses relative power on other matter. This is all the knowledge of both that is necessary to the due understanding of the system which I advocate. The other point is an irrelevant quibble. If we do not touch this or that body, we touch something which does touch it, and the result is the same. It signifies not, whether I push a billiard-ball with my finger, or with an intervening mace; nor whether the mace come into material contact with the ball, or only with its atmosphere; nor how many other things intervene, if the ball move in constant subservience to my will. To justify attraction by insinuations so utterly irrelevant, proves the desperation of its advocates.

OXONIAN.

I agree with you: I must, however, remark, that your demonstration goes only to prove that attractive force cannot proceed from the opposite sides of two bodies, whereas, the effect is often ascribed to something flowing between the bodies.

COMMON SENSE.

Choose, then, between absurdities. Such, too, is the theory of repulsion, and far more plausible, yet grossly absurd. But, if attraction were thus performed, the force must, nevertheless, be in the direction of the resulting motion. The supposed flowing atoms must coil round, and when so coiled, must have a force equal to that of the entire body, whence they flowed, for the results are reciprocally proportioned to the quantity of the two bodies. Again, after the atoms have left either of the two bodies, they are entirely independent of it; and, if they coiled round, their force would have no connexion with the body, whence they so whimsically issued. The notion is, to the last degree, puerile and absurd. Yet I know it is maintained even by La Place, who regrets the want of "new creations, to determine the velocity of the gravific atoms." !

OXONIAN.

Under your convictions, you must, however, give La Place credit for never speaking of projectile force.

COMMON SENSE.

In this respect, he is like others of the modern writers. He has no occasion for any force but the one which diminishes as the square of the distance, i. e. with the diverging force of a gaseous medium, on which I insist. But if he renders it a converging force, like attraction, then all the heavenly bodies would fall together. He cannot escape this dilemma. Newton was right in recognizing both forces; and La Place, and other moderns, are wrong, in giving up the one, without also abandoning the other. We must have both, and in full operation, or my theory of a single diverging force must be recognized. I thank you for these additional questions, and wish the advocates of the same doctrines would multiply them a hundred fold.

OXONIAN.

You introduced me to a new agent, in explaining the variation and dip of the magnetic needle. The phenomena require an action in the direction of the re-action; and an exhalation, which having permeated all terrestrial bodies, except iron, seems adapted to permeate them, as we behold in magnetism; yet, may not electrical strata, fining off between the poles and the equator, produce the effect?

COMMON SENSE.

The cause must correspond with the circumstances of the effect. It must not be forgotten, that the north pole of the magnet is the north pole in both hemispheres, and, consequently, the affection can arise from no relation between the poles and the equator, for the cause in one hemisphere would be reversed in the other, whether its direction proceeded from the equator to the poles, or the poles to the equator. An action, independent of mundane poles and equator, common to the whole, but varied in direction, seems indispensable—an action of which iron is the test; while an atmosphere of it, concentrated on iron, producing the local disturbance of the principles which cause electricity and galvanism, constitute the succession and conditions of the causes of this singular phenomenon. Iron is to be considered as the test of this action, just as the metals and non-electrics are tests of electrical action.

OXONIAN.

Would a man, placed in a point of space, in which he was the patient of no motion, be able to move his arm?

COMMON SENSE.

In reply to this conundrum, I state, that if there were no moving gas, whose energy could be transferred by the lungs, he could have neither life, nor any motion whatever. If in gas, yet without any thing to stand upon, and re-act against with his lower muscles, he could not move his arm. If in gas, with something to stand upon, the energy derived from gas would enable him to act with his lower muscles, and move his arm; but the re-action would confer an equal momentum in an opposite direction on the mass on which he would be standing. In every case, some previous motion must exist, and be appropriated; and subsequently be transferred to the mass, and by it to atoms, or other masses.

OXONIAN.

Then mind cannot originate motion?

COMMON SENSE.

Animal will may give direction to motion, but cannot originate it, or destroy it.

OXONIAN.

Have you any summary of the System which you espouse, or of its general principles?

COMMON SENSE.

None, in a few words, more complete, or comprehensive, than the following developement of the Laws of Motion by Sir Richard Phillips.

1. Matter never originates its own motion.

2. All motion acquired or possessed by one body, is the result of motion tranferred from some other moving body or bodies; and all motion lost by one body is transferred to some other body or bodies.

3. *Action* is the transferring of motion from the agent to the patient. *Re-action* is the reception of motion by the patient from the agent. They are, necessarily, equal and convertible terms,

4. No motion is created or lost, but is in a continued state of transfer, producing material changes, or phenomena, in atoms, or aggregates of atoms.

5. *Resistance* is the parting with motion to the atoms of a fluid, or solid, through which the moving body passes; and it is proportional to the density and the cohesion or viscidity of the patient.

6. *Friction* is the parting with motion by continuous contact; and is proportioned to the number of atoms of the agent opposed to the atoms of the patient.

7. Quantity of motion, (or *Momentum*,) is the velocity multiplied by the number of atoms moved. All momenta is the product of these two terms; and the presence of momenta is evidence of some matter and some motion.

8. *Weight* is the measure of motion, in a particular direction; and *inertia* is the measure of obstructed impulse. When the motions or impulses are common, as those of a planet, weight and inertia are as the number of atoms concerned.

9. The momentum of one body transferred to another body, confers on it an equal momentum; but if the velocity of either mass is obstructed, it distributes the momentum by the radiation of its parts, or re-actions of its atoms, producing the phenomena of heat.

10. A body in circular motion maintains a space, in proportion to its momentum; the occupation of an enlarged space, by the same bodies or atoms, is, consequently, evidence that they have acquired circular motion.

11. All acquired motions are susceptible of being increased and accelerated by renewed impulses, and hence the continued action of atoms on atoms, produces the varieties of heat.

12. Matter has no quality but that of exhibiting momentum or power on other matter when moved; and all material power, and change in the relations of bodies, affords evidence of matter in motion.

13. Impulse of motion is the transfer of motion, either by contact, or the intervention of a lever; and all motion received by impulse, is in the direction of the impulse.

14. **Levers may consist of either fixed, or fluid, or gaseous matter; levers of fixed matter transferring the entire impulse of the agent; but gaseous or fluid levers, in propagating or conveying the motion or impulse of any moving agent, radiate or diffuse the motion; therefore the momenta transferred through fluid or gaseous levers are, at different distances, inversely as the squares of the distances.**

15. **Through every species of lever, the direction of the motion acquired by the patient, is the direction of the simultaneous motion of the agent, and hence the curvilinear motions of the planets in beying the curvilinear motions of the sun.**

OXONIAN.

You have disposed of the fluid of heat (caloric), the fluid of light, the electric fluid, and the galvanic fluid,—What do you say of the nervous fluid?

COMMON SENSE.

The nervous fluid is an invention of a fluid, in supposed analogy with certain other fluids; but as these do not exist, so their prototype is, of course, a non-entity. Nervous propagation and medullary power produce an effect of their own kind, in all organized beings; but as every action on nerves is mechanical, and as similar causes produce similar effects, so the results must also be mechanical. This inference cannot be shaken, although the subtle phenomena of nervous sensibility, in the connexion of perception and nerves with muscles, may continue to baffle our analysis. Hitherto, powers acquired by practice have been confounded with mere original capability; these compounded results have then been considered as innate powers; and just conclusions have, at the same time, been obstructed by the jargon of scholastic metaphysics. The works of God, in the wonderful divisibility of matter, may never be thoroughly understood by beings of relative power; but the analogy of cause and effect, as exemplified in every part of nature, within our comprehension, ought to be admitted as proof, that the same sublime simplicity of equal action and reaction, governs the whole.

OXONIAN.

Do you consider affinities as mechanical?

COMMON SENSE.

Yes, because the notion of attraction and repulsion is essentially and radically absurd; and because the *forms* of the atoms concerned, and of those by which they are surrounded, would lead to their union, and sometimes to their separation. The elasticity or energetic motion of gas presses every thing lying within it, and other atoms are the yielding patients of this energy. Heat, or atomic motion, distends the atoms of solids, and occasions the appearance of repulsion; and round or prismatic atoms, insinuated in a solid of cubes, would decompose the whole. The local atmospheres of bodies have also much operation in varying, as well as in producing, these phenomena.

OXONIAN.

In speaking of the animal economy, I cannot withhold my surprise at the DEFINITE SIZE which animals and vegetables attain. Mechanical action would have no limit, and this seems at least to be a miracle.

COMMON SENSE.

All is miracle; and the more nature is examined the more exalted is our sentiment of omniscience. But this subject is not difficult. Definite size is the result of simultaneous increase and decrease. Eating and absorption are counteracted by evacuations and evaporations; and the two constitute a converging series, whose sum never exceeds a determinate quantity. Hence the limited bulks of things that grow. The powers of excitement wear out, and the being dies. The whole is like a curve, and all animal and vegetable life may be exactly exhibited by various forms of curves.

OXONIAN.

You referred to the Sun merely as the cause of motion, but our obligations to it are various.

COMMON SENSE.

The velocity of the sun's surface in contact with the medium of space, generates a direct propulsion of atoms, which falling on the surfaces of planets transfer their momenta, keep the atoms in motion, affect the atoms of their atmospheres, and rarefy them by expanding their orbits. There is, however, only mere motion and momenta in these radiated atoms; the heat is the result of reiterated, accelerated action and re-action, while light is another constant result. We are, therefore, indebted to the sun for a supply of heat and light, and for all the phenomena which they produce; and the sun is consequently at once the cause of our aggregate, and the source of our atomic motions.

OXONIAN.

How do you account for those singular bodies, meteorolites?

COMMON SENSE.

The collision of gaseous atoms are constantly consolidating them. Hence, as space is filled with gas, small aggregates are constantly forming, which float in space. The earth, in its orbit, encounters these, and becoming entangled in its atmosphere, and the patient of its motions, they are precipitated, like any dense mass, towards the centre. The rapidity of their accelerated motion, of course, creating their heat and light.

OXONIAN.

You have spoken of the atmospheres of bodies—what do you strictly understand by them?

COMMON SENSE.

There is an aerial action on every surface, of nearly fifteen pounds to the square inch, and, of course, from re-action, a condensation of aerial atoms on the surface. The effect is different on different surfaces, as they are rough or smooth, or variously constructed. From many bodies there is also an exhalation of the constituent parts, which, combined with the aerial atoms, varies the nature of their own atmospheres. From these causes arise the varied natural heat and cold of bodies, and their power of fixing atoms of oxygen; while again from this power arises their varied natural action on air, and other electrics; and, in fine, all the phenomena of electricity and galvanism. Many of the wonders of chemistry and optics arise also from these local atmospheres, and from the similarity and dissimilarity of their constituent parts. They deserve special investigation, and to be treated of as a separate branch of science.

OXONIAN.

As you so happily assimilate the actions of electricity, galvanism, and magnetism, I should be glad to learn what are your speculations in regard to the mode by which the excitement on one surface progresses through the intermediate space to the opposite surface, there producing a contrary excitement.

COMMON SENSE.

The whole is an affection of the surfaces, or the atmospheres of non-electrics, and of the constituent principles of electrics. In every case of electrical excitement, there must be a superficial connexion between the surface excited and the opposed surface, either by neutral, or semi-neutral surfaces, and a complete circuit of them. In an ordinary machine, the rubber must be connected with the remote surface, behind or beneath it, or it will not act. When a man rubs a glass plate with his hand, he must also be connected with the opposed surface, or be contrarily affected. The whole is a mere local disturbance of the opposed surfaces, in a complete circuit, in which something is withdrawn, as it were, from one, and transferred to the other. There must be an intermediate fluid, as in galvanism, or intermediate or circuitous surfaces, as in electricity, or permanent local disturbance, as on the connected surface of a magnet. By induction of electricity, as it is called, no more will be induced upon a surface than the sparks parted with to some surface connected with the opposite surface. As, however, the excitement is definite, so the effect is definite; consequently, when a neutral metallic surface, connected with the opposed surface, is itself opposed to any excited surface, the excitement is then concentrated in the intervening plate of air, and little, if any, affection takes place in the sphere at a distance. The great variety of the power of the opposed surfaces, and their different connexions with one another, creates, therefore, all those permutations of phenomena which have embarrassed this subject; but their true explications prove, not only that there is no fluid, *sui generis*, but that the whole proceeds from the local separation, or unequal division of gaseous atoms, by an appropriate force; while the re-actions attending their re-union, are forces capable of being specially directed. Hence the phenomena of our experiments.

OXONIAN.

Then, do you think that the atmospheres of conductors or neutrals have some affinity for the electrical principles, and that, for the time, those principles are incorporated, as it were, with those atmospheres?

COMMON SENSE.

No:—on the contrary.—The atmospheres of neutrals are altogether indifferent to either principle, while, on the contrary, electrics and their atmospheres are subject to the affections of either, and, if affected on the one side of the circuit by induction, are affected simultaneously on the other by reduction; and while receiving excitement, a circuit of surfaces passes from one side of the affected plate to the other side.

OXONIAN.

How is it, if I charge a coated plate of glass, or a Leyden phial, and discharge them?

COMMON SENSE.

It must be done by transferring an affection which exists in a circuit to one side, and connecting the opposite side with the ground, and completing the former circuit by more perfect neutrals than previously existed between them. The necessity of the circuit, in every case, proves not only my doctrine, but disproves all the nonsense about the common reservoir of the earth, bodies being imbued, &c. &c.

OXONIAN.

Why will not a rod of glass connect, as well as one of metal?

COMMON SENSE.

Because the glass becomes affected by the action, which action terminates, therefore, within the glass locally; and being exhausted in the glass at the place of contact, does not affect the air, consequently, does not make progress in the air, and progress in the stratum of disturbed or excited air, is the object to be achieved. Glass itself is not completely affected, except to a distance of about its own thickness, or the eighth of an inch.

OXONIAN.

Why does electrical action seek the best conductors, or, on your theory, the most perfect neutral surfaces, going miles through one instead of as many feet through others?

COMMON SENSE.

Because, as in the previous answer about glass, no restoration of a plate of air can take place, if the excitement is received and appropriated by an electric; and a non-affected surface transfers the action of the affected stratum of air, by simple propulsion, from one end to the other end of a plate, made by the continuous neutral surface.

OXONIAN.

As no surface can be affected without another surface being affected, what do you conceive is the dimensions of the sphere affected,—as in the instance, for example, of an insulated prime conductor, which has been separated from its glass excitor?

COMMON SENSE.

In the exciting of the surface of such prime conductor, a previous circuit was necessary. If the conductor were placed in a large sphere of air, the affection would radiate even for miles, the plate being ultimately determined by successive atoms of the air itself. But if any sufficient neutral surface or surfaces intervened, the effect would be defined by that surface, and the air would become an affected plate. In like manner, if any electric interfered, the effect would be continued through it, just as in air; but the excitement would be partly appropriated by the new electric, because every new surface presents some re-actions. If the interposed neutral were insulated, then its action would depend on its giving out sparks; and it is in this manner, that perfect neutral surfaces, partly insulated, give out sparks, in the presence of any electrical excitement, and, from the same cause, that persons are often killed by insulated neutrals, during a stroke of lightning, though not in the circuit. It is this lateral, induced, or opposing re-action, also, which affects the animal muscles, when an animal body is made part of the circuit. The exterior surface is in one condition, and the internal parts in the other, and the resistance of an imperfect electric, or neutral, creates what is called the shock.

OXONIAN.

How are wires and bodies fused during the passage of the aerial stratum?

COMMON SENSE.

By some obstruction or imperfection which occasions the opposite surface to meet the other at the place of fusion; and the re-union of the principles or disturbed surfaces, in so small a space, creates heat, light, &c. &c. The unobstructed continuity of the surface of a perfect neutral, creates no effect; but if the discharge or re-union of both principles, is, by its obstructions, made to take place upon it, then it receives the intensity of the concentrated spark, and is heated, or dispersed with violence. Hence the use of perfect neutrals in conductors of buildings, and the use of balls at their top, to enable them to act by induction. The idea of drawing off lightning by a point, is like whistling against the wind.

OXONIAN.

But when glass is thus affected, may not the coated glass create two near surfaces of two plates of air? May not the action still be made round the edges of the glass, and the apparent affections of glass, after all, be but affections of air?

COMMON SENSE.

I think not; for, if the glass be half an inch thick, no effect will take place on the glass, and a quarter of an inch would make no difference in the action of a plate of air. Glass, therefore, is affected through its interior, when the obstructions are not rendered too great by its increased thickness.

OXONIAN.

But what is the action when we rub a solid glass tube, a stick of sealing wax, or a plate exciter, upon both sides at once?

COMMON SENSE.

The effect is imperfect, and much action is lost; but in either case, if there is not some opposing action in an excited solid electric, then the adjoining plate of air is the excited electric, and the contrast is afforded by the plate of air adjoining.

OXONIAN.

As you ascribe the gaseous form of matter to the revolution of the atoms in orbits, and heat to those atomic motions, how do you explain the phenomena of coldness in steam when raised to a very high power? I am sensible that this is a difficulty on the calorific theory; for if the steam is created by caloric passing into the interstices between the atoms, and the quantity of caloric is then proportioned to the expansion, the heat ought to increase in the same proportion. Either the expansion is not created by caloric, or the caloric is not heat. I do not insist on the existence of the calorific fluid, I merely state the received Theory.

COMMON SENSE.

You have so candidly stated the question, and so plainly proved the absurdity of the prevailing nonsense on this subject, that it only remains for me to give my illustration. By expansion, or high power of aqueous gas, I understand nothing more than the enlargement of the orbits of the atoms by the increased transfer of momenta to them. The fixation of gases by the fire under the boiler, transfers nearly the whole of their previous motions to the fluid within the boiler. The atoms rise into the gas in the vessel, and this deflects them into orbits, while they operate, in their turn, on new evolutions of the atoms. The original excitement, or the gaseous fixation being continued, the motions of the atoms of confined gas are, in consequence, accelerated; and hence the increased power of the steam. It is atoms driven into enlarged orbits, by great and continued motions. Now the sense of heat requires that the percussions should be often reiterated, as in the case of vision from light. But, if the orbits are so enlarged as to be fewer in a given space, and consequently strike a certain point less than the number of times necessary to perception, then the sense is not affected. Add to which, there is an increased vacuum between the atoms, and therefore a simultaneous evaporation from the skin, which creates a sense of coldness when the finger or hand is plunged into it.

OXONIAN.

Why does not the elastic force of steam follow the Law of Temperature, or, on your theory, of Atomic Motion?

COMMON SENSE.

Because the atoms are accelerated, or motion is added to motion, and a series of pressing or elastic forces accumulated, like that of falling bodies. In all cases, elasticity, expansibility, and condensation, arise from the varied sizes of the orbits of the atoms concerned, while orbits depend again on the excitement and its continuity.

OXONIAN.

As the fluctuations of the barometer seem not to depend on temperature or elasticity, are they not to be ascribed to some connexion with the lateral action of the atmosphere ?

COMMON SENSE.

Yes, for if I throw a stone horizontally, while the full impulse continues, it has no downward tendency. The same general principle affects the weight of the atmosphere, when moving laterally, or in a wind. The downward tendency must always be mechanically diminished by such horizontal motion, in proportion to the lateral velocity. Some winds bring an accumulation of atmosphere, others are deficient in quantity. Sometimes, a current in the upper atmosphere will have the same effect as one in the lower atmosphere, and hence we have variations without sensible causes. Other things alike, the weight of the atmosphere must depend on its lateral velocity.

OXONIAN.

Does the moon raise aerial tides, and affect the weather ?

Common Sense.

No. The waters, as non-elastic fluids, obey the swing created by the re-action of the moon; but not so, elastic fluids. The moon changes fifty-two times in every year, and the weather a hundred times; hence, the two changes often coincide in time, but without connexion as cause and effect.

Oxonian.

What is boiling, in fluids?

Common Sense.

The expansive motion of the combined gas, which takes place either when atmospheric pressure is removed, under the receiver of an air-pump, or when atomic motion is communicated by fixing other gases in combustion. These phenomena prove that fluids consist of compound atoms, floating as it were in gas. When the gas is extracted, or fixed, the fluid solidifies, owing to its atoms being no longer kept asunder, or afloat, by the gas in the interstices. The varieties in the weight, and the volatility of fluids, depend on the excess or deficiency, and the species of these gases. The conversion of ice into liquid is affected by exciting the fixed gases; and it is the same in metals, only there is a correlative re-action of the contained and the atmospheric gases.

Oxonian.

What say you of *tones* in sound?

Common Sense.

That the different gases, separately affected, produce them. That the whole mass is not affected by each vibration, but each tone is produced by vibrations capable of affecting particular gases, hence particular tones; and from this cause we hear three or four tones at the same instant of time. The same common medium could not display the simultaneous varieties of an orchestra. If nitrogen is a compound, then three atmospheric gases would, separately and by permutation, produce the entire octave. But atoms of carbon may also be concerned.

OXONIAN.

Colours, in like manner, seem to be a combination of three powers acting upon the retina.

COMMON SENSE.

Oxygen, combustibles, and, generally, carbon, are necessary to the creation of light, and the wick of a candle may be regarded as an optical, or, by analogy, a musical, instrument, played upon by oxygen, which exhausts its energy upon it; the carbon, nitrogen, and hydrogen, being the substances or strings moved or impelled, and producing the radiations of colours.

OXONIAN.

Are there not striking analogies between several of the atomic phenomena?

COMMON SENSE.

Several, and all arising from the correlative and sympathetic actions and re-actions of the atoms which constitute the gases, which relations are consequences of the necessary harmony and fitness by which they fill space with the least interference. This is demonstrated in combustion, light, electricity, galvanism, magnetism, &c., but is always the effect of re-action. This mechanical sympathy fixes oxygen, when hydrogen is evolved by motion, and is then called combustion. Light affects a sphere, and has its transparent exciters, and its opake non-conductors; and Electricity, so far, is like it, but the former is propagated directly by protrusion, in the shortest line, and electrical action proceeds on the surfaces of perfect neutrals. Light and Sound differ, inasmuch as the first is connected with chemical decomposition and simultaneous protrusion; and the other is propulsion without decomposition. Galvanism is Electricity excited in a particular manner; and Magnetism is similarly contrasted, but the materials affected, as far as experiment has gone, seem to be different. Heat is mere atomic motion, propagated by exciting the rarest gases, and distributed rather than propelled. In truth, with reference to cause and effect, to agents and re-agents, there is much analogy in the gaseous state, but it is destroyed and impaired by the varied re-actions of solids. With types and symbols we have no concern.

OXONIAN.

But are not these general resemblances capable of some association, calculated to elucidate the mechanism of their causes?

COMMON SENSE.

This general association leads us merely to their general cause, *matter in motion;* while the special causes in the same general sense, are the relative motions of the atoms of gases, in particular relations to other atoms, and to their own motions, in the re-actions of solids.

OXONIAN.

How do you reconcile with your theory, the deflagration of the gases, by contact with porous platina?

COMMON SENSE.

The question obliges me, because it enables me to advert to another analogous phenomenon little understood. When it is proposed to accelerate crystallization, we introduce a foreign body to serve as a nucleus, to which the atoms may attach themselves, parting with their remaining motion by simple contact. Crystallization is the mere packing of atoms, in subserviency to forms; and the packing force is that of the elastic medium by which they are surrounded. It is, with regard to liquids, what combustion is with regard to gases; both are mere processes of fixation. The porous platina serves, then, exactly the purpose of the solid in crystallization. It affords a nucleus which commences the process of fixation, and the gases collapse into water, giving out heat, or atomic motion, by their reduction of volume; and also light, by the affection produced by the heat or motion on the adjoining atoms, which receive it. The whole is a mere process of parting with motion, facilitated by a surface of great conducting power, the porous form of which creates numerous actions and re-actions.

OXONIAN.

How do your doctrines accord with the phenomena of the gaseous blow pipe?

COMMON SENSE.

The phenomena of the blow pipe presents a variation but no objection. The great power of this instrument is caused by the fixation of much more oxygen, owing to its previous combination with the hydrogen. The mass is affected, but in an ordinary flame only the surface.

OXONIAN.

It is a general but confused opinion that electricity plays some part in the animal economy.

COMMON SENSE.

The surface of the lungs was not made equal to that of the exterior skin without design; and neither the red blood becomes purple, nor the purple blood, red, without cause. The idea accords with the presence of nitrogen in animal bodies, and the fixation of oxygen in the lungs. It illustrates the action of many remedies, applied to the skin, accounts for its odour, and accords with the pulsation of the system.

OXONIAN.

Has not Davy made an *experimentum crucis*, to prove that electricity exists in an aerial vacuum?

COMMON SENSE.

He bounded his vacuum with glass, and passed a wire through that electric! An acidulous action was transmitted along the wire, and the outside of the glass shewed that the glass itself received the excitement, not the vacuum.

OXONIAN.

Have you considered the odd and curious results of some modern experiments in electro-magnetism?

COMMON SENSE.

I repeat, that the connexion of electrical and magnetical action was established full a century ago. The unseen agents acting differently on the same bodies, and differently on each other in connexion with different bodies, produce reciprocal effects, which enable experimentalists to pass for conjurors among the vulgar. A magnetized bar, or part of a bar, presents, in its local atmosphere, a variety of the galvanic combination, in which the principles are, however, so varied, so attenuated, or so masked, as to prevent deflagration, on completing the circuit.

OXONIAN.

How do you describe the source of power and energy in steam engines?

COMMON SENSE.

The energy of a steam engine is a transfer of the energy which previously existed in the gas of the atmosphere, fixed by the fire. The energy derived from the same liquid, is as the gas fixed,—that is, the motion exerted by the engine is as the motion parted with by the gas fixed during the combustion. The only differences are, the quantity radiated, or laterally imparted during the process, or dissipated, from want of skill in managing the excitement. The progress is thus:—the atmospheric gas parts with motion at the fire; that motion is partly radiated and dissipated by the fire, and partly communicated to the boiler, or steam generator; through this, the motion passes into the water, and evolves its atoms in circular orbits, as gas; these circular orbits fill a larger space, in proportion to the excitement, and its acceleration; and this expansion, duly appropriated, constitutes the power of the engine. Stop the access of air to the fire, and the engine stops; fix less air, by diminishing the fire, and the power is diminished. The whole is a transfer of motion, from one set of atoms to another. The gaseous motion fixed, constitutes the heat of the fire—the heat itself is atomic motion,—it is received by the boiler and water, and gas,—and then by the piston and apparatus. There is no caloric, and the idea is as absurd as it is gratuitous and fanciful; and there is no motion lost or gained. The motion previously existed, and always exists in the gas of the atmosphere,—it is concentrated by the combustion, which is essentially an act of concentration—it is scattered and dissipated by the pipes, the evaporation, and radiation; and the portion which is directed towards the apparatus, is by it transferred to the earth, or returned to the atmosphere.

OXONIAN.

How do you explain the operation of Mr. Perkins's new steam generator? He resorts to the doctrine of caloric. Can it be reconciled with your theory of atomic excitement, and with its usual laws of transfer?

COMMON SENSE.

The basis of Mr. Perkins's improvement, consists in his bringing water into actual contact with the metal, by which the excitement is directly communicated to the water, which excitement, heretofore, has been allowed to dissipate itself, by the simultaneous generation of steam. The atomic motion, transferred by the fixation of the gases in the process of the external combustion, passes through the substance of the vessel containing the water, and its first effect has been to convert the adjoining liquid into steam. Room being allowed, in ordinary boilers, for the expansion of this steam, the ultimate force consisted only of the first simple force; or, if accelerated, the acceleration depended on the vague dimensions and decreasing strength of an extended surface of boiler. But Mr. Perkins has contrived to press his liquid into his boiler or generator, home to the interior surface of his generator, and to keep it full, so that no steam can be simultaneously generated; and hence, as the motion transferred by the fixation of the gases in the adjacent combustion is not simultaneously distributed in steam, the contained water receives all the acceleration of excitement of which it is susceptible. This accumulated excitement does not, however, burst the generator, because the strength, other things alike, is inversely as the dimensions, and the thickness can conveniently, in so small a bulk, be increased to any required degree; thus, less of the motion transferred from the combustion is lost, than when, by the old system, steam was simultaneously generated; and the continued addition accelerates the excitement of the water, on the principle of accelerated motion in falling bodies. From this effect of acceleration, which cannot be complete in an ordinary expanded boiler, Mr. Perkins obtains great excitement with much less fuel, or less gas-fixing, by combustion. He loses no motion, and he appropriates the whole by an accelerated result. The expansive force is all the motion of the gases fixed by the combustion; and as long as the strength of cohesion in the materials of the generator is greater than the expansive force, no explosion can take place. But as soon as Mr. P. has sufficiently excited his water, he allows some of it to escape, and every drop then evolves in steam many hundred times the original bulk. The excited atoms, of course, perform large orbits, creating a local vacuum, therefore, a perception of coldness to the evaporating hand plunged into it, and a force of expansion, equal to any required, as 500lbs. or 20,000lbs. to the square inch. It is a case of power resisted. The confined atoms of water are not to be supposed at rest; on the contrary, no motion is lost or gained, in the whole process. It previously existed in the gases of the atmosphere;

these are fixed by the combustion, which is a mere process of gaseous fixation; the generator and its contained water are placed in contact; the atoms in water receive the motion, but are unable, for want of space, to exhibit any of it in forming steam; the continuance of the transfer of motion causes acceleration, and an effort to escape, which is prevented by re-action, till the excitement is sufficient to evolve gas of the required power. Rationally explained, Mr. P.'s machine is founded on principles strictly philosophical:—he has safely generated a force before unknown, and if he had failed to apply it with skill, his past reputation, as a mechanic of the first order, would have been undeserved

OXONIAN.

I thank you for amplifying,—but as the force is as the combustion, so, small combustion, other things alike, would not yield equal force, and hence, a liquid more volatile than water, would not, as gas, produce the effect of aqueous gas.

COMMON SENSE.

I conceive, not, in general,—but the consideration is mixed,—for as liquids consist of component atoms, which are surrounded by gas, or the interstices of which are filled, more or less, with gas in an active state; and as various atoms present varied re-actions to the same excitement, so the particular results in expansive force may be very different with equal excitements, or may be the same with different excitements.

The very volatility and rarity of some fluids, as compared with others, proves the difference of their structure and constituent parts; and though bearing the common name, and general character of liquids, yet volatile liquids are almost gas, or gas more than fixed atoms, and become wholly gas with very slight additional excitement. Their expansive force is, consequently, not simply as the new force transferred by combustion; but in different liquids, is as their own constituent excitement, combined with the force of combustion; though in the same liquid, other things alike, it is directly as the force transferred by combustion.

OXONIAN.

Of course, then, less heat or motion is transferred in forming volatile liquids from gas, than in the formation of water, and other liquids less volatile, because the quantity of motion continues the same under the various transformations?

COMMON SENSE.

Generally speaking, this must be the law; but owing to the varied combinations of the condensed gases, the experimental results may not constantly agree with it, though every disagreement must be evidence of special re-actions.

OXONIAN.

The President of the Royal Society may, therefore, be right, in supposing that mechanical power may be derived from volatile liquids, with less combustion than from water.

COMMON SENSE.

The principal may not be wholly erroneous as a speculation, but as matter of practice, it is entirely useless. Nature supplies us with water free of expense, and art with volatile liquids at vast expense. Rapid condensation is impracticable, and the application could be made only in high pressure engines, wherein all the gas escapes, and its costly liquid would, of course, be lost. Nevertheless, M.M. Perkins and Farrady, deserve renown for proving the relative permanency of the gases, and every opinion of the ingenious President is always entitled to respectful consideration. *Till we have fallen upon a method of applying gases themselves in various degrees of condensation, as contrasted mechanical powers,* we must be content to regard Mr. Perkins's contrivance for producing the same power with one gallon of water as with sixty, and with one bushel of coals as with four, as the limit of human ingenuity in this branch of human art. At the sametime I am persuaded, that the application of the force transferred by combustion through water, for the purpose of arriving at mechanical power, will by posterity be considered as a very bungling procedure; and I think that it has been continued merely because mankind have been confounded by the nonsense about caloric, and, in consequence, have not understood the nature and source of the power which they were applying.

OXONIAN.

In a former discussion, you remarked that the same changes of terrestrial force, which cause its orbit to be elliptical, create the surprising geological changes on its surface. Do you mean the Neptunian changes as they are called; those which indicate so plainly the submersion of the land by the sea?

COMMON SENSE.

I mean those changes. I maintain that, as the waters enlarge their own bed by attrition, made evident by the acute angles of Southern America and Africa, so the line of Apsides progresses through the ecliptic; consequently, when the perihelion point reaches the signs of great northern declination, the seas which now preponderate in the southern hemisphere, will then preponderate in the northern hemisphere, and the northern continents and islands be submerged. Cause and effect harmonize in this case, as in every other, and the successive changes are confirmed by the fossil remains and geological appearances in every part of the world.

OXONIAN.

The line of Apsides, if its motion is equable, performs a revolution in 21,000 years, or from tropic to tropic, every 10,500; you think, then, that each hemisphere is subject to alternate submersions, during those periods; in parts of which periods, the seas are gradually encroaching and retiring with reference to the varied changes of declination, arising from the varied angles of parts of the ecliptic to the equator. But would the difference of the mundane forces be equivalent to the required rise of the waters?

Common Sense.

The difference is as the square of 92·5 to that of 96, or nearly as 21 to 23, or one-eleventh of the whole force; if, then, the average depth of the ocean is about 12 miles, we have cause for a direct rise of nearly 6000 feet, without considering tides, excess of land, &c. and of course, therefore, water enough for all the phenomena, even those on the highest mountains.

Oxonian.

I am struck with this solution of a mighty mystery; but this does not account for the remains of natives of the tropics, found in such abundance in the northern regions, and often in such recesses as preclude the idea of their being wafted there by the ocean.

Common Sense.

We know that the action of the solar forces tends to bring to the same plane the counteracting forces of the orbit and rotation, and that the tropics are in consequence constantly narrowing. The causes would render this quantity a decreasing series. It is now a degree in 7000 years, probably it was a degree in 1000 years when the angle was greater, as 40 or 45 degrees, and in 40 or 50,000 years, the tropics may have narrowed from 45 to 23 degrees. Tropics 90 degrees wide, would change the climate of every region, and the fruits and animals of the tropics might flourish every where. The gradual narrowing of the tropics, and the intermediate submersions of the two hemispheres, meet every case of the geological phenomena. Volcanos, pressure, chemical composition, and decomposition, filtration, percolation, and mechanical action of water, will explain the details.

OXONIAN.

I am aware that with physical science, the moral Revelation through the Scriptures have no necessary connexion, yet in facts, they ought to accord. How are these doctrines to be reconciled with the one, universal and transient deluge insisted upon by our professor Buckland?

COMMON SENSE.

I confess I am astonished, that the professor of any science, in so distinguished an University as Oxford, should have proved himself so unacquainted with his Bible. Does not Moses distinctly treat of a previous and more permanent deluge, than the one about which this able geologist confines all his enquiries? The sacred historian expressly declares, that previously to the commencement of his history, "the earth was without form, and void, and that the Spirit of God moved upon the face of the waters; and that God said, let the waters under the heavens be gathered together unto one place, and let the dry land appear; and it was so. And God called the dry land, earth, and the gathering together of the waters called he seas." Here, a deluge is described of much greater importance and duration than that on which Professor Buckland has so strongly insisted, and which, if the only deluge recorded by Moses, would have been so unequal to the phenomena. The old writers fell into this error, and the Professor has inconsiderately trodden in their steps.

OXONIAN.

But do your astronomical periods accord with the Mosaic chronology, in regard to changes, which might accord with his general representations?

COMMON SENSE.

Perfectly so;—almost to a year;—more exactly than either free-thinkers, or believers in miracles, would wish. The perihelion passed the equator exactly 4002 years before Christ, causing the waters of the northern hemisphere to retire to the southern, or so equalizing their action, as to leave the elevated tracts of the northern hemisphere dry; and in the year 2258 B. C. it reached a middle southern declination, producing about that time, a maximum of effect in the equatorial regions, in such floods drawn from the north, as may have produced a general deluge in the equatorial regions, at the epoch of Noah's flood. Indeed, during the whole period of the passage through Libra, or in 1744 years, the changes from water to land would be more sudden, operative, and perceptible, than at any other period, in the northern hemisphere; and when they had passed away, the traditions of the people would accord with the short notices given by Moses. On this subject, we witness effects, and the accumulation of the waters in the southern hemisphere, in exact accordance with the present delineation of the perihelion. We know, also, that the line of Apsides makes a revolution of the ecliptic, as a consequence of changes in the position of the mundane forces, which forces appear to be connected with the position of the waters. Hence, we connect general causes with the effects, and arrive at a satisfactory solution.

OXONIAN.

You have frequently alluded to fitness and harmony—I suppose you do not mean that fitness of things caricatured by Fielding and Voltaire—nor the harmonic numbers of Plato?

COMMON SENSE.

Fielding and Voltaire perverted in order to caricature. They allude to *moral* fitness, which, as depending on the passions, prejudices, and interests of men, is an absurdity. On the contrary, *physical* fitness is one of the most sublime and universal results in nature. Nothing exists which is not fit, or if it exist and is not fit, it is a monstrous production, and soon exterminated. With the reveries, the fancies, and metaphysics of the Platonic school I have no alliance, but I use the word harmony as the result of fitness or accordance. *In all these discussions, the poverty and ambiguity of language exposes one to quibbles and pretended contradictions.*

OXONIAN.

In a former dialogue, methinks you have been disingenuous towards Newton about the doctrine of attraction or gravitation, for he specially guards himself against being considered as using the terms as a cause, but only as the name of the effect.

COMMON SENSE.

The want of fairness began with Newton, who guards his supposed discovery like the specification of a patent, which generally includes as an overwhelming clause, the phrase "and by whatever other manner the same may be produced." But it is not his causation, though his term implies a cause, that I dispute, but his actual effects. He appeals from the visible phenomena of the fall of a projectile to those of the heavens, and describes the mutual gravitation of the sun, the planets, &c. as visible effects of a similar cause; and on the ground that these phenomena are sensible, applies to them the same term, as a proximate cause, which he applies to the fall of terrestrial bodies. Now no such effect is sensible in the heavens, and there is no connexion whatever, real or apparent, between the cause of the fall of a body and that of the motions of the heavenly bodies. The one is a local centripetal force, created by the local motions of the aggregate, and the other is a diverging force propagated from body to body through the medium of space. The divergence creates the law of the inverse square of the distance, while the direction of the force is directly the contrary of that which

Newton described as visible, and as similar to that of falling bodies. Nor did he end there, for as his universal force was active, and, therefore, in spite of equivocation, a special and proximate cause of these phenomena, he then invented a counteracting projectile force, also active, or cause on cause, one in error, and of course, the other. He states too, that the cause, whatever it might be of his gravitating power, is indifferent; whereas it is not so, for although the law which he adopted from Hooke happened to be the law of divergence, yet as he adopted a converging force in analogy with terrestrial centripetal force, and the true cause is the divergence of motion, all his analogies and reasonings are false, and his system of causation, as a system, utterly fails.

OXONIAN.

What is your opinion of Comets, bodies which Newton considered as the renovators or fuel of the exhausting sun; and of their tails, which he maintained were renovators of planetary atmospheres?

COMMON SENSE.

I consider Comets as bodies unattached to any stellar or solar system, originated and accumulated by conglomerations of the gaseous medium of space, and concentrated by alternate heat and cold into solid masses. They continue unattached while they pass as germs of planets in certain angles and velocities, through the planes of solar and planetary vortices, and may often become attached as planets or satellites when they enter these vortices in acute angles. I have already described the composition of forces which generate their orbits. With reference to their restoring the exhausting sun, the idea is absurd, seeing that there are so many millions of suns; and also that on my hypotheses of light it is not necessary that the identical atoms should depart from the sun's body. The idea about the tails is still more whimsical. All the phenomena prove that the luminous projection is as often a head as a tail, for they are constantly in a right line from the sun, transparent, short and long universally as their distance, and divided in the middle by the nucleus, consequently, they consist merely of light refracted through the peculiar atmosphere of the comet, which is visible by reflection from the medium of space. The notion of their attracting planets, causing deluges, &c. is on a par with that of their portentous effects on the affairs of mankind.

OXONIAN.

I perceive you have confined your explanations entirely to active phenomena, of which motion is a constant adjunct, but there are many phenomena of solids at rest which seem to require powers *sui generis*, or with which we are utterly ignorant.

COMMON SENSE.

All the wonders of solids arise from an element which we are unable to use in our experiments. That element is Time. It is this element which creates most of the varieties of the mineral kingdom. Terrestrial centripetation causes universal pressure; this again, general action and re-action, and filtration and exudation. As the smallest atoms are the most affected, so aggregates formed of these are unlike all ordinary bodies. Heat (atomic motion) acting too for many centuries, causes subterraneous circulations, while obstructions and re-actions produce various concentrations, accretions, and combinations, of whose origin and progress the life and observation of man can have no cognizance. These are strictly phenomena of atomic forms, resulting from slow action in long time, unconnected with chemical tests which we derive from the gases of the atmosphere, or from distinct combinations of other mineral bodies. Add to which, if the earth, as appears evident from a thousand appearances, has been subject to an intense action of fire, perhaps in a cometary state; and the land has since been subject to alternate submersions of the ocean, we have in these causes a general solution of the varieties and incongruities of the various minerals. In regard to organized bodies, I cannot become physiological, but it appears generally that vegetables grow and assimilate minerals and gases; and are mechanical and chemical preparations of the food and substance of animals. Each of these kingdoms, as they are called, is a consequence of the other; while the superabundance of animals renders it necessary that many animals should be carnivorous, and they are accordingly without sympathy, and insensible of the golden rule of morals. It is a circle of existence, physically fit and harmonious, and dependent in all its parts; but too vast to be regulated by the selfish policy of man, and too complicated in its various elements, and in their infinite permutations, in numbers and quantity, to be fully comprehended by his finite and relative mode of reasoning.

OXONIAN.

Most systems of philosophy commence with theories of the creation.

COMMON SENSE.

And thereby the authors make fools of themselves. The very notion of a sudden creation is the greatest of all absurdities, and contradicts our daily experience. Every thing arrives, or has arrived progressively at the state in which we find it. The progression never ends, nature is never idle, and the work of creation is proceeding as rapidly and effectually at the instant in which I am speaking, as it ever did at any moment of time.

OXONIAN.

But is not this idea contrary to scripture?

COMMON SENSE.

Ido not think so.—Genesis speaks of, *thebeginning*, as a remote eternity of time, and then treats of the progression of beings in *days*, usually considered as metaphorical, bringing down the world to the state in which it then was ; and historically describes the successions of beings and events, down to the epoch of the writer ; while, in the intervening time, all kinds of progresive creations must have regularly proceeded. To conceive a cessation of progressive power, is to think irreverently of the Deity. Nevertheless, the idea of creative power, bespeaks a beginning of all special things ; while the beginning of any special thing is but a continuity, and far from implying the commencement of creative power, which must have been as eternal as the Deity.

OXONIAN.

The atheistical school of Epicurus taught absurdly enough, that the collisions of atoms produced all things, and that there were corporeal and intellectual atoms. These are not features of your system.

COMMON SENSE.

My system is at war with the pride and presumption of man, in treating on subjects beyond his power of reasoning, from observation and analogy. I turn with disgust from the writings of world-makers. The collisions of all the atoms in the universe, in millions of years, could not produce a hair of my head ; and look to the multitude of fit and dependent causes necessary to produce it. Contemplate, also, other objects, infinitely more complicated, and dependent on other things equally complicated, yet accordant; and then refrain, if you can, from yielding your humble homage to an eternal and omniscient CAUSE of CAUSES.

OXONIAN.

I have little to urge in opposition to doctrines so plausible, yet one ought not quietly to surrender principles so long cherished. I cannot at once abandon all that I have studied for forty years. How do the critics and the world treat the system of which you are the advocate?

COMMON SENSE.

Exactly as might be supposed. Pride is wounded. Many have written and published extensively on the old theories, and thus cannot allow the labours of their lives to be compromised. As the anonymous critics cannot answer, and dare not grapple with the arguments, they only revile and mis-represent. They adopt the author's meaning in a half sense, or they pervert his meaning, and they then draw from their own misrepresentations ludicrous conclusions, and achieve easy victories over their own fancies.

OXONIAN.

I can readily conceive that the vulgar arts of sophistry would, on such occasion, be brought into play. They answer the purpose, however, only for a season. We can never forget the two Professors who demonstrated the *impossibility* of Galileo's telescope; nor the assertion of a great chemist, about the gas lights of Winsor, who was suffered to linger in obscurity,

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while nations were deriving enjoyment from his labours.

COMMON SENSE.

One laments such obliquities of moral feeling and reason. The panders of prejudice are, perhaps, more base than feeble. They hope to please their superiors, and obtain profit and promotion. In this view one cannot wonder that a coxcomb within his wrangler's moon, should exert his pedantry in a servile Review; nor that a young surveyor, or two or three country schoolmasters, should enter the lists against truth; nor that a clerical Review should cry Infidel! Seeing the wires that move such puppets, one is not surprised at their tricks.

OXONIAN.

Nevertheless, they surprise and delight the multitude.

COMMON SENSE.

And so does Punch; but no man of sense plumes himself on being an admirer of Punch. The mob of small thinkers may be satisfied with the feats of these several Punchinellos, and these facetious gentlemen may have thrown dust into the eyes of others; but the former are beneath notice, and the latter will, in due time, recover their powers of intellectual vision. Such, however, is the fate of every attempt to reform old opinions and practices. The multitude never think, but they allow interested knaves or conceited pedants to guide them.

OXONIAN.

Doubtless it thus happens that most improvements are either deferred or frustrated; but it is a consequence of the conflicting passions, at the same time it is a condition which we may lament, but to which we are obliged to submit.

COMMON SENSE.

I do not mean to censure the moral feelings of the parties: many men are not free agents, and others do not choose to encounter the obloquy of new opinions. Action and re-action govern the social as well as the physical world. Non-conformity is often dangerous, and always inconvenient. The spirit of intolerance is not wholly confined to religion. Even when self-interest is not at issue, pride and prejudice create an equal degree of stubbornness. In short, most men are the dupes of education. The philosophical prejudices of the present time originate in a supposed alliance between the principles assumed by Newton, and his geometrical demonstrations. I wish to wage no war against prejudice. Time, and a new generation, are the sure allies of truth. Among philosophers little is opposed to truth, but associations and close corporations in which, as the errors of one age are unavoidably cherished in the next, the progress of truth is retarded, and its ascendancy postponed. In such matters even Books, the constant illuminators, fail. They are mostly written for temporary profit, and few Authors can afford to print any but popular opinions. Knowledge progresses through minds as variably as heat progresses through bodies; and some minds are so imbued with it, as to be incapable of receiving more, while others are so untractable, as to be incapable of receiving any, except what passed through their posteriors at public schools. Of this variety, all extended societies are more or less the patients; and it is their necessary misfortune, not their deliberate fault. If to this condition be super-added, the results of election by ballot, or the propagation of members by breeding *in and in*, according to the Bakewell system of large carcase and small intellect; and the monstrous incongruity of close corporations, in which every succession is necessarily a degree of intellect below that which went before it,—then the fatuity of such social combinations is complete.

OXONIAN.

You are severe,—but I am glad you attach no moral fault. Associations beget affections, and these tolerate mutual errors. Ambition, too, yields; and the applause of multitudes is delusive, yet not to be obtained without flattering their prejudices How would you correct the evil?

COMMON SENSE.

By not allowing cabals to govern in the renovations of societies. Confer on every five or six members the privilege of nominating a candidate, who, after a year of probation, in regard to personal conduct, should then be considered one of the society. Let the system of ballot only be applied to ejection, on due presentation for improper conduct. A society so constituted, might be subject to more friction than a close corporation, but a system of action and re-action is the soul of the world. Without it, associations must be worse than useless, if their purpose is the improvement of knowledge, and their object the respect of the good and wise.

OXONIAN.

I am amused by your applying the idea of action and re-action to the social and philosophical world. Would not, however, such principles deprive animals of free agency?

COMMON SENSE.

I think not. If animals were simple levers, they would certainly be the mere patients of external excitement. But an animal is not only a compounded lever re-acting against the earth, with branching muscular levers acting in every direction; but an assemblage of levers of different kinds, producing results, on which we can reason from no gross analogy. The discriminating senses, and the experience which begets comparison or judgment, would be useless, if they did not govern the Will. But the will is not, therefore, the patient of external excitements; for the senses and the experience vary in all animals; and, therefore, the judgment varies which directs the will. Animals are patients only in regard to things not cognizable by their powers—and patients in degree, as they are young, inexperienced, or ignorant. The excitements may be the same, but they affect levers differently trained, and produce different results. The Will is the focus of all these levers; and its instrument, the Nerves, (the sublimest of material productions) are so delicately constituted, and so subject to exhaustion, as to require the frequent renovation of their powers, by the mechanical secretions of the whole animal economy in the inactive periods, called sleep

OXONIAN.

I perceive, then, that men are free, even to do wrong; yet is not Philosophy under the highest obligations to associations of learned men—witness the Royal Society of London and the Institute of France?

COMMON SENSE

No one reverences those bodies and their labours in collecting facts and improving natural history more than I do. The History of Nature, and Registers of facts, have been multiplied in their hands beyond all that could have been expected. But the Registry of Facts is not philosophy—they have left philosophy, or the investigation of causes, exactly as they were in 1656, when the Royal Society commenced. And they have done worse, they have mingled the old theories of causation with their accumulated facts, and have distorted and caricatured nature. I do not quarrel with them for accumulating facts—

they are the only basis of reasoning—yet the making of such accumulations is not Philosophy.

OXONIAN.

But the sagacious experimentalist is a useful pioneer of Philosophy, and without him we could make no real progress. Have we facts enow from which to draw correct inductions?

COMMON SENSE.

Yes, quite enough to make better inductions than had been made in 1656. To experiment with constant reference to absurd causes is a waste of labour. If Copernicus had not developed the true causes of night and day and the seasons, before these Societies existed,—some old cause would have been assumed, and our knowledge limited to observations on day and night, and on seasons; but this would not have been Philosophy! Such registry would have been simple Natural History, while Copernicus's explication of the causes, was the Philosophy of these phenomena. It luckily was a true explication, but if the observers had received a false hypothesis, and their observations had been made in subserviency to it, we should at this time have been, perhaps, further from the truth, in regard to the simple causes of these great phenomena, than we were when the observations began.

OXONIAN.

I cannot suppose that you desire inductions relative to causes to be made previously to an assemblage of facts. I concede however, this much, that we ought from time to time to review our assumed causes, and beware that they do not mislead our experiments. Thus far every friend of Philosophy cannot but concede, while he will be jealous of premature conclusions. We may however exclude what is palpably false without danger, and reason and experiment would then go hand in hand, and our knowledge of nature be prodigiously accelerated.

COMMON SENSE.

This is all that can be desired; but there is a vast difference between the stubborn maintenance of principles divulged in the infancy of science, and the progressive improvements which you suggest. Gilbert was in keeping with his own times when he conceived the existence of a magnetic fluid; Newton when he adopted the old principles of material attraction and repulsion; and Hooke when he taught the Laws of universal gravitation: but it is ignominious to recognize such fancies in our times, because they happened to be promulgated by persons who, in their general characters, are entitled to our veneration. Men are the patients of the prejudices of their own times; and generally the times and their education, and not their minds or morals, are to blame; but, aware of this imperfection of our intellectual condition, we ought never to consider ourselves either too old or too wise to receive further instruction.

FINIS.

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ERRORS OF THE PRESS.

Page 20, line 14, for *and* read *or.*
101, line 2, after question, convert the *full point* into a *comma.*
102, line 9 from bottom, *dele the mark of interrogation.*
111, line 16, read *are circumstances.*
116, line 3, read *its*
172, line 2, *dele the second to, and place a semicolon after atoms.*
185, line 3 from bottom, in *exposes, dele the s.*
191, line 6, *double the s in progressive.*

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